



Digital Electronics for High School Curriculum

An Interactive Qualifying Project Report

submitted to the Faculty

of the

WORCESTER POLYTECHNIC INSTITUTE

in partial fulfillment of the requirements for the

Degree of Bachelor of Science

By

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Abstract

The purpose of this project is to assist a Worcester public school named Doherty Memorial High School with the development of instructional curriculum related to an introductory digital electronics unit. A series of lectures and a digital clock laboratory are constructed to augment the curriculum, to improve circuit building skills, and to engage students in the everyday application of digital technology. The culmination of this work is published in the TeachEngineering digital library, a resource dedicated to engineering education.

Acknowledgments

We are extremely grateful to our advisor Prof. Martha Cyr for her help, support and guidance. We would like to thank the teachers, Mr. John Staley and Mr. William Hankey, and the students of Doherty Memorial High School for taking time out of their schedules to aid us in our project. Finally, we appreciate the help given to us by Prof. James O'Rourke, and Mr. Tom Angelotti from the Electrical and Computer Engineering Department of Worcester Polytechnic Institute.

1. Introduction

At the end of the 2006 school year, the team for this project was beginning its search for the proper Interactive Qualifying Project (IQP) to fulfill a graduation requirement here at Worcester Polytechnic Institute. After meeting with professors in a variety of academic departments, this project was selected by the team to undertake during the 2006-2007 academic year. The project initially sounded appealing to the team because the IQP worked with high school engineering students, something we thought would be interesting and fun; and also the team saw it as a way not only to fulfill a graduation requirement but also contribute to improving Worcester public schools. The mission of this project was to work with Doherty Memorial High School's (DMHS) Electrical Engineering class.

The overall stated goal of the project in the beginning was slightly vague. Because of the loose structure of this project the team was given freedom to experiment, try new ideas, and work with professors, teachers, and students to create a project that could benefit Worcester's public education program. This project is a culmination of ideas and work of the team, WPI professors, Worcester public high school teachers, and Worcester high school students. Through our collective efforts this project underwent continual stages of improvement and evolution to finally reach this finished project.

The entire project proved to be an incredibly rewarding experience when we were able to work with the students at Doherty Memorial High School. This experience was the first time anyone in the team had the chance to work with students in high school. The chance to help out local students and improve their understanding in areas of science and engineering was exciting. Ultimately, the team hoped that our efforts helped young students learn and gain an appreciation for engineering. Perhaps our efforts would provide a bridge to the work they will soon be doing in college, give all the students a head start to following in our footsteps, and one day becoming our colleagues.

The report that follows will outline everyone's efforts during this entire process. What the team did during this project was design a digital clock experiment that the students could participate in to learn about electrical engineering. Many other supplemental tools such as activities and lectures were used in correlation with the activity to further strengthen the educational value of this project. To assess the team's success, pre and post examinations were given to the students to determine if they had gained any knowledge by

participating in this project. Ultimately, the team hopes that this project will be available to teachers around the country by submitting the team's work to academic resources.

2. Mission Statement

This project is intended to assist Doherty Memorial High School in Worcester, Massachusetts to develop enhancements for the school's introductory digital electronic curriculum, by constructing effective lessons and a feasible laboratory activity to reinforce the curriculum. In order to fully maximize the performance of this project, the team will be working with the students by testing their knowledge before and after the material is presented to them. Based on the results, the team will analyze the effectiveness of the activity and the students' performance. The students will also provide their overall conclusions of their experience which will allow the team to ascertain modifications to maximize the learning benefits.

3. Background of Doherty Memorial High School

In the process of creating this activity, teachers and students from Doherty played a major role. One of the teachers taught 11th grade electrical engineering class and the other one taught a 12th grade practical engineering class. The teachers planned to add digital electronics topics on top of their analog electronics material. It was the first time that they taught digital electronics in their school. Our group worked with them to create an activity which helped students to learn digital electronics. The students who participated in our IQP project were all from the Engineering and Technology Academy. In order to make an activity which matched the students' needs and the teacher's expectations, our team studied the background of the school.

The Engineering and Technology Academy (E.T.A.) at Doherty Memorial High School

Doherty Memorial High School is a public high school located at Worcester, MA. When students enter the 9th grade, they can decide to join a 4 year program which is known as the Engineering and Technology Academy (E.T.A.). The E.T.A. began in 2002. It emphasizes project-based learning practices. It incorporates technology in all subject areas. It is also a college preparatory program that emphasizes strategies to improve organizational skills and study habits needed to succeed in the rigorous academic program of study.

The principles of Engineering and Technology are a common thread throughout the program. All students in the program learn to use the "Engineering design process, the scientific method, Microsoft Office package, Internet Explorer, and AutoCAD 2002"(Doherty Memorial High School, D.M.H.S.). Students also have the opportunity to learn laboratory instrumentation, graphing calculators, hand tools, power tools (e.g. CNC, miter saw), Electronic Circuits, Meters, and Programmable Logic Circuits.

The focuses of the first two years in the Academy are the core academic subjects and courses that focus on engineering and/or technology. All the fundamental skills and knowledge are taught in order to ensure them success in the program. In grades 11 and 12, in addition to the academic courses and the principles of technology and engineering, students may select to participate in courses such as Electromechanical engineering, Practical engineering, Graphic design, and Computer-assisted design. In their senior years, students may also participate in an internship and/or enroll in advanced placement courses.

The electrical engineering class (11th grade students) is one of the classes in E.T.A. The courses description is as follows: “This course focuses on advanced circuitry and electronic principles. Students analyze the fundamentals of circuit design and component function. Students learn digital electronic systems that include binary, octal, and hexadecimal systems. Students are exposed to robotics design, assembly, and programming. Students use AutoCAD2002” (D.M.H.S.).

Before our IQP project, the students in this class were working on a programmable remote control car. They needed to assemble the car and write a program which enabled them to control the car. Completion of this project would indicate they had a solid electronics background.

The practical engineering class (12th grade students) was the first group of students who participated in the activity. This group of students had learned the material from the electrical engineering class which they took in 11th grade. When they participated in this project, they were preparing for internships in local engineering companies which would allow them to apply their engineering knowledge and competency.

The Mission of the Engineering and Technology Academy

There are a number of aspects in the mission of the E.T.A. In the program, students participate in activities which teach them various disciplines of engineering and technology. The program creates a collaborative environment for students, parents, staff, and members of the community to work together to improve the future of each student. By involving different people in the program, it allows the students to apply their knowledge outside the classroom (D.M.H.S.).

Besides achieving the mission statement, the teachers want the students to have a new mindset after finishing the program. The students learn to use methods of inquiry. They also learn effective ways of organizing, evaluating, and analyzing information. Students should be able to apply past knowledge to new situations, think critically and creatively, and communicate with clarity and precision. The program is also a great opportunity for students to reconfirm their interest before landing in an engineering or technology field in their higher education.

The Vision of the Engineering and Technology Academy

The Engineering and Technology Academy is a program that allows students to make good use of their knowledge to solve real-life complex problems. Students also learn to work independently and with other students and faculty members through different projects. The program stresses “mutual respect, individual responsibility, integrity, and a commitment to academic excellence”(D.M.H.S.). Besides traditional lectures, there are other learning opportunities including learning fairs and exhibitions which allow students to demonstrate what they have learned.

In order to fulfill the vision, school teachers have brought in innovative topics and real world experience into the program. In the past, a WPI IQP team had worked with them to create an activity which allows students to understand and implement the mechanics of flight. In 2003, students in the E.T.A started to have chances to do a 20-week co-op with local area businesses and companies. In 2006, our team worked with them on introducing digital electronic topics to their students. Also, the school was recently in discussion with Quinsigamond Community College to allow their students to receive credits for the electrical engineering course at Doherty.

For the future, they are planning to work on complex activities. Some of the topics and activities that they are interested in include alternative power sources such as solar electricity and bio-diesel. Possible projects include installing a solar panel on the school’s roof to power a class room, and the refinement of bio-diesel.

Conclusion

Understanding the background of the school helps us to set our goal and the approach to reach it. We know we are working with dedicated teachers and students who are interested in practical activities. The students are likely to enter colleges. These factors are important to our activity’s design because it shows where the program is now and where they want to be in the future.

4. Methodology

Introduction

Before undertaking the task of improving the digital electronics program at Doherty Memorial High School, the first thing that needed to be determined was the areas within Doherty's curriculum that required adjustment. After a plan of action was decided, certain steps were devised and executed to insure optimal success for the team's project. In order to undertake this task, a series of goals were developed to provide a timeline and guide for the team's efforts. The complete process of this project was divided into many stages.

Determining Improvements

Doherty Memorial High School's electrical engineering program is an introductory course offered to any interested students who are either juniors or seniors. The course is taught over the duration of an entire school year and is broken into two segments. The first segment covered is known as their analog unit which covers the fundamentals of electrical circuits. The focus of their analog chapter concentrates on learning basic principles such as voltage, currents, resistance, Ohm's Law, and capacitance. The analog section of the school's course also introduces students to other basic electronic components such as BJT transistors, metal oxide silicon field effect transistors (MOSFETs), diodes, and light emitting diodes (LEDs). The second half of the school's electronics unit focuses on the fundamentals of digital theory. This part of the curriculum was the focus of the project. What the team aimed to do was find ways to improve this aspect of their program.

The current digital program allows students to learn basic digital concepts by introducing students to the language of electronics; as well as teaching them fundamental ideas like binary coded decimal, and hexadecimal systems. In order to understand what aspects of their curriculum needed improvement, the overall depth and content range of the schools curriculum needed to be understood. To accomplish this goal, a series of meetings were held with faculty members in April of 2006. During these meetings with the teachers the main topics that were discussed dealt with what the students were learning; and what they would like to see improved with their program.

Some areas the teachers felt needed improvement were the activities that students used in class. Previously, the students used electronic kits that were sold under the names of

“Dr. Circuit” and “RC Car”. Both labs were flawed in the fact that they allowed little critical thinking to perform. Also, the simplified step by step instructions that came with the labs did not incorporate the theoretical concepts used in class. After further meetings with the faculty in April, May, and September, of 2006, it was concluded that the program lacked an activity that tied the concepts learned in class to real world applications. At this juncture in the project, the team was now focused on designing and implementing an activity that would improve the class’s laboratory exercises.

When the previously stated goal was established, it was then necessary to fully comprehend the depth of the school’s curriculum. This was achieved by working with the faculty and analyzing their course syllabus.. Also the team felt it would be important to see how the students learned, and how a high school electrical engineering class is taught. To see a class and meet with some students, each team member attended an electrical engineering class in May of 2006. What the team observed was a class focused on learning the fundamentals of digital electronics. The classroom format was very interactive; the teachers constantly asked questions in which the students answered. This method kept the students constantly engaged in the material. In the end, the visit to the classroom gave the team insight into how the digital material is presented to the students. It was then concluded that the designed activity should try to incorporate interactive learning and critical thinking.

Determining the Student’s Activity

When formulating ideas and considering a list of goals for a proposed activity, it was important for the team to first consider the limitations of possible projects. A main limitation to any proposed idea was to produce an activity under a budget of around \$200. Producing a project as cheaply as possible was important not only because of limited budget, but also because we wanted to have our finished product utilized by other schools in the future. By producing an activity that can be cheaply recreated in a classroom, the finished product will therefore be more affordable for schools. Another limitation was time constraints. Any idea that was proposed for possible consideration first had to be analyzed to insure that the activity would not take a long time to complete. The final important limitation facing the group was that it was decided that the project should abide by Massachusetts educational standards.

The first activity the team contemplated building was a digital adder/subtractor. Ultimately, this activity would illustrate in a fundamental manner how a computer microprocessor is able to do simple arithmetic. In the process of performing this proposed lab, students would construct two major components. First, they would have to build a multiplexer or decoder to demonstrate how data could be encoded or decoded in a computer. Second, they would have to build a decimal counter that would display a numerical value. We felt this activity had very high educational value, but undertaking this project posed some major problems. After estimating the total cost of constructing such a lab, it was found the final cost would be over the project's allotted budget. In total, undertaking this project would cost the team over \$300. Even with the expense of the proposed activity it was also found that the lab would take too long for the students to complete. The estimated time it would take the students to complete the entire activity was around four to five hours. Teaching the students how the whole electrical system worked would take around two weeks to complete. Although the lab would provide the students a very educational experience, the proposed activity's downfalls were found to be too substantial for the team to undertake during this project.

Moving away from the adder/subtractor, the team began to brainstorm and research other possible ideas. What the team was able to formulate through this process was a series of possible activities. One major development from this stage was the decision to have the proposed project incorporate an application of digital technology that students are exposed to in their everyday lives. The reason for taking this new path was decided upon under the notion that incorporating an activity that tied what students see in their everyday life, would add educational value to the future activity. If a student could build and learn about something they use in their everyday life, they would be able to gain more of an appreciation for digital electronics. Using that philosophy, the team began investigating possible activities that used digital electronics in everyday applications. At this juncture in the project, two more possible ideas that could be utilized in the classroom were formulated.

The first idea the team decided to investigate was the traffic light model. This activity would incorporate the student's knowledge of logic gates. The finished design that students would construct would incorporate three LEDs. One LED being green, one yellow, and one red like in a standard traffic light. The circuit would also contain various integrated circuits, and passive electrical devices such as capacitors and resistors. Students would also

have to construct a timing circuit that would control what LED lit up and what LEDs would be turned off at a given time.

The second choice was to build a digital clock. This activity would incorporate the students understanding of binary numbers. Before undertaking a digital clock project, two options had to be considered. One of the options was to build an entire digital clock. This meant the constructed circuit would perform the same timing mechanism as a digital clock found in stores today. The other option was to build a portion of an actual digital clock. This option only required the students to build a one-minute digital clock. In other words, the digital clock would count from zero to fifty nine. The clock would then cyclically repeat the process over again beginning at zero. After performing a value analysis based on several factors such as: the cost, time constraints, and complexity, the one minute digital clock option was arrived upon because it was found to be more appropriate. The time and cost investment of building an entire digital clock would be too substantial for this project. If the team at that point decided to implement a one-minute digital clock circuit, our final design would consist of two seven-segment Liquid Crystal Displays (LCDs), some ICs, and some passive electrical components.

Now that both possible project ideas had been researched, the team now had to consider which activity would be the best path to pursue for this particular project. Both projects were estimated to be of the proper intellectual level for a high school junior. Both projects used concepts that the students had learned in class and applied those concepts to real world applications. Both activities were estimated to cost around the same amount of money to produce (\$150-\$200). However, it was estimated that the traffic light model with its larger amount of components would take slightly longer to complete. By the team's best estimates, the one minute digital clock would take around three hours to build and around two hours to teach the students how the clock worked. The traffic light model, on the other hand, was estimated to take about five hours to build with an additional three hours of teaching the students about it. After looking over the Massachusetts Educational Standards, it was found the digital clock experiment incorporated more of the Massachusetts Educational Standards than the traffic light model. Because of these stated reasons, it was decided that this project would be to develop a digital clock activity that the students of Doherty Memorial High School could use in class.

Massachusetts Education Standards

At the designing phase of this activity, the Massachusetts Educational Standards have been carefully looked at. So other educators who are working within the Massachusetts Educational Standards can easily understand what this lab is aiming for, and the educators can fit this activity into their courses more easily. This activity matches parts of the Vocational Technical Education Framework, and the Massachusetts Science and Technology/Engineering Curriculum Framework.

Vocational Technical Education Framework (Manufacturing, Engineering, and Technology Cluster Electronics):

In this project, the students were required to build a digital electronic circuit prototype based on a schematic. In order to achieve this goal, students needed to learn different skills such as, assembling electronic circuits, using digital instruments, performing calculations, and understanding applications of digital devices. These skills matched the requirements in the Vocation Technical Education (METCE) Framework. The following tables are the skill sets which are listed in the METCE Framework.

Assemble electronic circuits

Table 4.1 lists a set of skills that are about assembling electronic circuits such as identifying assembly and packaging related hardware, identifying electronic components, layout of electronic circuits from schematic diagrams, and constructing an electronics circuit prototype. Students needed to demonstrate these skills in order to finish this lab. In this lab, students were given a set of different electronic components and they needed to follow the instructions and schematic diagrams to put them together. They also needed to layout electronic circuits on the breadboard in a way that was easy to debug. By the end of the lab, they finished constructing an electronics circuit.

Table 4.1: METCE Framework Section 2.G

2.G. Assemble electronic circuits
u Manage electrostatic discharge
u Identify electronic schematic symbols
u Draw a schematic diagram
u Create a parts list
u Identify assembly and packaging related hardware
u Identify and inventory electronic components
u Layout electronic circuits from schematic diagrams
u Construct an electronics circuit prototype
u Place components using correct polarity and orientation
u Simulate a circuit using a computer application
u Identify capacitors and resistors and their appropriate uses

Use digital instruments

Table 4.2 lists a skill set about using digital instruments such as logic probes, pulser, multi-meter and oscilloscope. Different measurement instruments such as a digital multi-meter and the oscilloscope were used in this activity. They were used to measure the flow of current, total resistance, and the output voltage as a function of time produced by the 555 timer and other electrical components.

Table 4.2: METCE Framework Section 2.Z

2.Z Use digital instruments
u Use logic probes/pulser and multimeter
u Demonstrate the use of a multi-channel oscilloscope and logic analyzer
u Use a signal generator

Apply electronic principles of digital circuits

Table 4.3 states that the students need to understand and identify different digital circuits such as 7400 series, digital oscillator, and logic gates. In this laboratory, the 7400 series chips such as 7447 and 7490 were introduced. This activity required the students to understand these chips and to use them in circuit designs. By learning the 7400 series chips' internal structure and functionality the students acclimated to the function of different logic gates and flip-flops circuits which were found inside these chips.

Table 4.3: METCE Framework Section 2.AA

2.AA. Apply electronic principles of digital circuits

- u Identify high and low and tri-state characteristics of a digital signal
- u Identify basic TTL gates of the 7400 series and explain IO characteristics
- u Identify pin numbers and manufacturer markings on digital IC's
- u Identify differences between TTL and CMOS logic families
- u Identify and calculate parity bits for error control
- u Identify the universal properties of nand and nor gates
- u Identify alternate schematic forms of basic logic gates
- u Identify various combinational and sequential logic circuits
- u Identify reduction theorems used to simplify digital electronic circuits
- u Identify the basic architecture of a microprocessor or microcontroller
- u Demonstrate an understanding of PLA devices
- u Demonstrate an understanding of line driver characteristics and applications of its uses
- u Identify a digital oscillator circuit including the 555
- u Identify circuits that perform A/D and D/A conversions

Perform calculations and applications of digital devices

Understanding truth tables, converting numbers between binary and decimal, and drawing logic diagram from Boolean expression are some of the example in table 4.4. These areas were well covered in this lab. The 7490 created numbers in binary format, and the students needed understand the concept, so they could convert binary numbers in decimal. Also, in order to understand the function of each integrated circuit in the lab, students needed to have read different truth tables.

Table 4.4: METCE Framework Section 2.BB

2.BB. Perform calculations and applications of digital devices

- u Use the two's complement number system for math operations
- u Convert between binary, decimal and hexadecimal numbers
- u Identify and use alternate digital codes
- u Draw logic diagrams from Boolean expressions
- u Write truth table from a Boolean expression or logic circuit
- u Use reduction theorems to simplify digital electronic circuits
- u Develop waveforms for latches/flip-flops
- u Develop counter circuits waveforms

Verify digital devices

To successfully finish this activity, the students needed to demonstrate skills of wiring and testing combinational logic circuits such as encoding and decoding circuits. They also needed to construct, simulate, and troubleshoot circuits based on their understanding of truth tables and logic circuits. This skill set is listed in table 4.5.

Table 4.5: METCE Framework Section 2.CC

2.CC. Verify digital devices

- u Verify truth tables of basic gates
- u Wire, test and explain combinational logic circuits
- u Wire and test various flip-flops to verify truth tables
- u Wire and test various latches to verify truth tables
- u Measure waveforms for counter circuits and analyze behaviors and characteristics
- u Construct, simulate and explain encode and decode circuits
- u Construct, simulate and explain shift registers
- u Construct, simulate and explain comparators
- u Construct, simulate and explain adder circuits
- u Construct, simulate and explain multiplexer IC's
- u Troubleshoot basic combinational logic circuits
- u Troubleshoot basic sequential logic circuits
- u Construct and analyze a digital oscillator circuit including the 555
- u Construct and analyze circuits that perform A/D and D/A conversions

**Massachusetts Science and Technology/Engineering High School Standards
(Technology/Engineering):**

Engineering Design

In Massachusetts Science and Technology/Engineering High School Standards (MSTEHSS) engineering design “involves practical problem solving, research, development, and invention/innovation, and requires designing, drawing, building, testing, and redesigning. Students should demonstrate the ability to use the engineering design process to solve a problem or meet a challenge”(Massachusetts Department of Education, 2006).

This project gave the students basic ideas of how to solve a practical problem by using engineering skills. They needed to interpret different plans, diagrams, and build a device that had a real world application. They built a digital clock in this project by following instructions. They needed to test it, change different settings, and retest it. By finishing this lab, students learned the main concepts of the engineering design. The details of Engineering Design section in MSTEHSS are listed in table 4.6.

Table 4.6: MSTEHSS Section 1

- | |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ol style="list-style-type: none">1.1 Identify and explain the steps of the engineering design process. The design process steps are identify the problem; research the problem; develop possible solutions; select the best possible solution(s); construct prototypes and/or models; test and evaluate; communicate the solutions; and redesign.1.2 Understand that the engineering design process is used in the solution of problems and the advancement of society. Identify and explain examples of technologies, objects, and processes that have been modified to advance society.1.3 Produce and analyze multi-view drawings (orthographic projections) and pictorial (isometric, oblique, perspective) drawings using various techniques.1.4 Interpret and apply scale and proportion to orthographic projections and pictorial drawings, such as, $\frac{1}{4}'' = 1'0''$, $1\text{ cm} = 1\text{ m}$.1.5 Interpret plans, diagrams, and working drawings in the construction of prototypes or models. |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

Communication Technologies

Massachusetts High School Standard also believes that communication Technologies involves “applying technical processes to exchange information can include symbols, measurements, icons, and graphic images. Students should demonstrate the ability to use the engineering design process to solve a problem or meet a challenge in a communication technology” (Massachusetts Department of Education, 2006).

Our project related to the communication technology because it helped the students learn to differentiate between digital and analog signals. In the lab, the students used a power supply to generate an analog voltage and then transformed the signal into digital by using a 555 timer integrated circuit. Then this circuit generated an electrical pulse every second, and served as the timing device. This process of translating between digital signals and analog signals is an important concept in communication technologies. The details of the Communication Technologies section are listed in table 4.7.

Table 4.7: MSTEHSS Section 6

- | |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none">6.1 Explain how information travels through the following media: electrical wire, optical fiber, air, and space.6.2 Differentiate between digital and analog signals. Describe how communication devices employ digital and analog technologies, such as, computers and cell phones.6.3 Explain how the various components and processes of a communication system function. The components are source, encoder, transmitter, receiver, decoder, destination, storage, and retrieval.6.4 Identify and explain the applications of laser and fiber optic technologies (such as, telephone systems, cable television, and photography).6.5 Explain the application of electromagnetic signals in fiber optic technologies, and include critical angle and total internal reflection. |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

Prototype Design

Having made a decision to develop the digital clock project, it was necessary to design a prototype. Before designing the schematic, we performed research on how the digital clock was constructed. After a few days of researching, a block diagram that illustrates the main internal components and the relationships among those components of the digital clock was defined. Technically, the digital clock's block diagram contained four main modules; they were: the 555 timer, the decade counter 7490, the BCD¹-to-seven-segment-display driver 74LS47, and the 7-segment LCD² display. Figure 4.1 shows the block diagram.

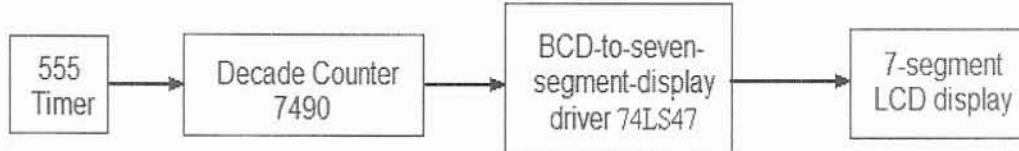


Figure 4.1: Block diagram of the digital clock

The first module, the 555 timer, was an IC³ and produced a 1Hz signal at the output pin 3 in Figure 4.2. In other words we wanted the 555 timer circuit to keep time by sending an electrical pulse to the second module, the decade counter 7490, every second. In fact, the 555 timer module was not just solely an IC. There were some external electronic passive components such as resistors and capacitors associated with the 555 timer IC. The 555 timer IC datasheet provided several typical applications for this IC. One of those met our needs. The one that we chose was a complete circuit in which the values of the resistors and the capacitors were left for the users to define. The external components determined the frequency of the output signal because the frequency was computed by the following equation:

$$f = \frac{1}{0.693 \cdot C \cdot (R1 + 2 \cdot R2)} \quad (\text{Equation 1})$$

¹ BCD: Binary Coded Decimal

² LCD: Liquid Crystal Display

³ IC: Integrated Circuit

The parameter f in the above equation represented the frequency of the output signal. The parameter C was the capacitance, and the resistances were represented by $R1$ and $R2$. Figure 4.2 depicts the 555 timer circuit in which the above parameters were illustrated.

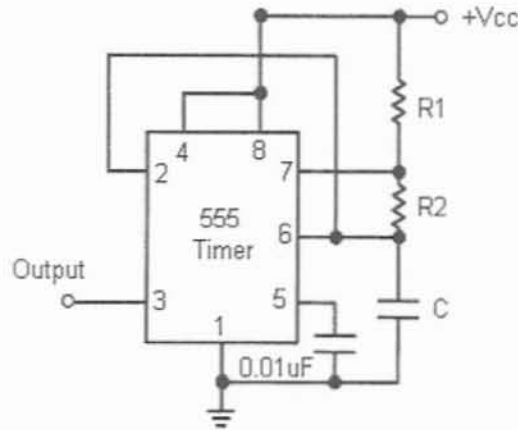


Figure 4.2⁴: Typical application of the 555 timer circuit

In our design, C was chosen to be $100\mu\text{F}$, $R1$ was $2\text{k}\Omega$, and the desired frequency f was 1Hz . Therefore, the resistance $R2$ was obtained by applying equation 1 as follows:

$$1\text{Hz} = \frac{1}{0.693 \cdot 100\mu\text{F} \cdot (2\text{k}\Omega + 2 \cdot R2)}$$

$$\Rightarrow R2 = \frac{1}{2} \left(\frac{1}{0.693 \cdot 100\mu\text{F} \cdot 1\text{Hz}} - 2\text{k}\Omega \right)$$

$$\Rightarrow R2 = 6.2\text{k}\Omega$$

With the specified parameters C , $R1$, and $R2$, the circuit in Figure 4.2 produced a 1Hz signal. In fact, the frequency would not be exactly 1Hz because of the tolerance of the resistances. However, a value ranging from 0.9Hz to 1.1Hz would be acceptable. In general, the first module provided a timing mechanism for the digital clock.

The second module, the decade counter 7490, was an IC which is depicted in Figure 4.3. This IC would count the number of electrical pulses arriving at the input pin 1. The number of pulses counted would appear in binary form on four output pins 8, 9, 11, and 12. It should be noted that the 7490 IC would only be able to count from zero to nine in decimal

⁴ Refer to appendix A4 – 555 Timer

value. When the tenth pulse arrived at the input, the binary output would be reset to zero, and the IC would start counting from zero. To fully understand the 7490 IC's internal structure, the behavior of each pin, and other the characteristics, the IC's data sheet was attached in the appendix A4 for reference.

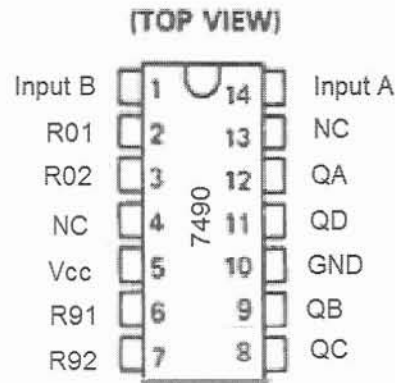


Figure 4.3⁵: The decade counter 7490 IC

The third module, the BCD-to-seven-segment-display driver 74LS47, was also an IC which is shown in Figure 4.4. We discussed earlier that the 7490 IC in the second module had four output pins corresponding to four bits of a binary number. This binary number would have a decimal value ranging from zero to nine. The 74LS47 IC in the third module took the four outputs of the 7490 IC and converted them to seven outputs. The four input pins of the 74LS47 IC were 1, 2, 6 and 7; the seven output pins were 9, 10, 11, 12, 13, 14, and 15. To fully understand the 74LS47 IC's internal structure, the behavior of each pin, and other the characteristics, the IC's data sheet was attached in the appendix A4 for reference.

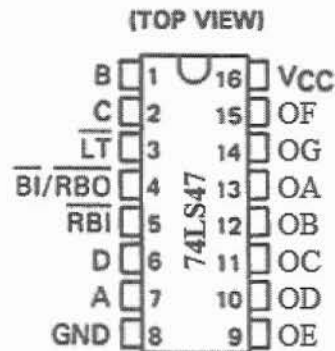


Figure 4.4⁶: The 74LS47 IC

⁵ Refer to appendix A4 – 7490 Decade Counter

⁶ Refer to appendix A4 – 74LS47 BCD Driver

The last module was the 7-segment LCD display and it received signals from the 74LS47 IC's output pins. The internal Light Emitting Diodes, LEDs, of the 7-segment LCD display would be lit up depending on the signals coming from the seven outputs of the 74LS47 IC. If the coming signal was high or five volts, then the corresponding LED would be turned on. In contrast, if the signal was low or zero volts, then the corresponding LED would be turned off.

After defining the characteristics and understanding the functionalities of each module in the block diagram, the next step would be to generate the schematic by utilizing the MultiSim software. The simulation process took several days to complete because the team was not familiar with the software. However, the schematic for constructing the prototype of the digital clock was eventually finalized. After that, a list of components that would be used to build the prototype was created. Some components were purchased from Digikey⁷ and Mouser⁸, and some were purchased directly from the shop in the Electrical and Computer Engineering department. The team's advisor provided a nice breadboard incorporated in a suitcase which was portable and useful. Before constructing the prototype, the team had no concern in using the laboratory equipment such as oscilloscopes, multi-meters, and power supplies because one of the team members was an Electrical Engineering major.

The building process began as soon as all the components and parts were received. The 555 timer circuit was the first part that the team built by following the schematic. It did not take the team lots of effort to build this timing circuit since it was relatively simple. After making all necessary connections, the team utilized the oscilloscope to test the output of the 555 timer circuit in order to verify whether the output frequency was 1Hz. The obtained value was 0.92Hz which was acceptable.

After that, the first counter which would count from zero to nine was built. It should be noted that the digital clock had two counters that represented two digits of the digital clock. The clock was only able to time from zero to fifty nine seconds cyclically. This should explain the reason of naming the project as "One minute digital clock". However, after building the first counter, it did not behave as expected, and the team failed to troubleshoot. Thus, the team decided to build the second counter which would count from zero to five.

⁷ Digikey: Electronic components distributor – www.digikey.com

⁸ Mouser: Electronic components distributor – www.mouser.com

Again, the second counter failed to achieve the goal. After a couple of days of troubleshooting, the team was still unable to find out the problems. Fortunately, with the help of Professor James O'Rourke in the Electrical and Computer Engineering department, the digital clock was debugged successfully, and it eventually worked correctly. As soon as the prototype was completely constructed, it was showed to the team's advisor. Then, the team performed modifications to make the digital clock prototype more compact and aesthetic by rearranging all the wires and replacing all the resistors between the 74LS47 IC and the 7-segment LCD display with network resistors. Figure 4.5 shows a complete prototype of the digital clock.

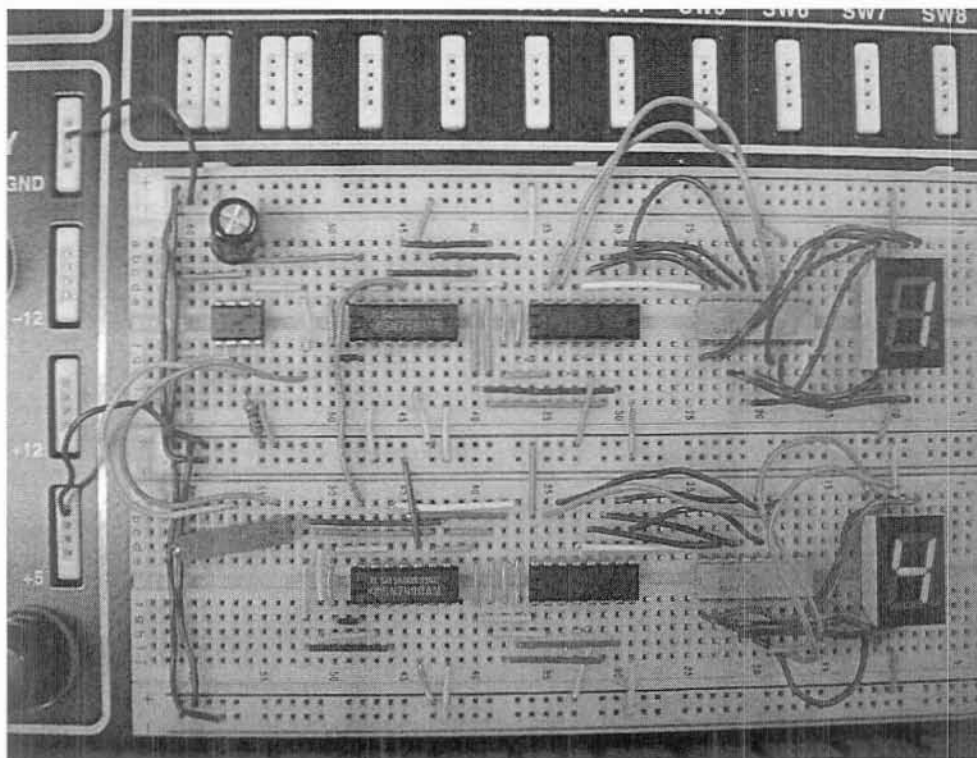


Figure 4.5: The one-minute digital clock prototype

Determining Activities Procedure

After completion of the prototype, it was now possible for Doherty's electrical engineering class to begin utilizing the digital clock activity. What now needed consideration was what method would optimize the overall educational value of the projects finished activity. To go about this the team consulted with the teachers and our IQP advisor on possible methods. Some of the ideas that were formulated were to use pre and post activity examinations as a way to measure what the students had gained by participating in the project. Students would take a quiz before and after the activity. Both quizzes would contain similar content and be of relatively equal difficulty. Ultimately, to gauge the success of the activity the scores of the both tests would be compared. If a significant increase in the student's scores was observed, it was presumed that this would indicate a success. By scoring better on the post test, presumably the student had gained knowledge by participating in the activity.

The second idea that was formulated was to have a series of lectures that would be taught by each team member. The content of the lectures would be about the digital clock students needed to construct. The lectures would show how the digital fundamentals they learned in class could be applied to real world applications. By the end of the presentations, it was hoped that all students had an understanding of the digital clock and how it worked. As a way to assess the team's progress in this area, the data that was recovered from the student's pre and post tests was gathered and analyzed.

The team ultimately decided to break the project's lectures into three major parts, each part representing one of the three important components that made up the project's digital clock design. The three lecture series consisted of one lecture dedicated to the 555 timer circuit. The lecture would go into how and why the 555 timer was used in this project's design. It would also talk about how the 555 timer works. The second lecture would be dedicated to talking about the 7490 decade counter. This presentation would focus on how the device worked and why it was incorporated into the digital clock design. The third and final presentation would be about the 7447 BCD Driver and the 7 segment liquid crystal displays. This lecture would take the information from the two previous lectures and show how the clock's LCD displays are able to show an output and display numbers. The

presentations were introduced to the students using power point slides. The power point slides can be seen in the following appendix A3.

The third idea that was formulated was to test the activity and lecture series on two separate groups of students. One group of students would be a class of senior students that tried the activity first. These senior students had already completed the electrical engineering course the year before. That first group of students after completing the lab would provide us with information, feedback, and suggested modifications. The team would then use the student's feedback to improve the lab. After improvements were made, the second group of students, which was a class of junior students would try the lab after modifications. This second group of students would consist of the students this project was intended to help. By conducting the project in this manner, it allowed for modifications to strengthen its educational value.

The fourth and final idea that was formulated was to create a questionnaire that the students would complete after participating in the activity. The questionnaire would consist of a series of questions that the students would answer. Each question was scaled from a range of 0-5 where 0 was a negative answer and 5 was the most positive answer. It was felt that the questionnaire was necessary in order to gauge whether or not the students enjoyed the activity. The questionnaire also served as a way for the students to provide information, feedback, and possible modifications. The questionnaire, as well as the student's responses, can be found in the attached appendix A9.

In order to verify that the team's method was consistent with published research that dealt with technology education, several research papers were consulted. The first paper that was examined was titled "Engineering Principals for High School Students". This particular study focused on measuring the effectiveness of a proposed engineering curriculum. The engineering curriculum was designed to "increase the awareness and competence in various areas of engineering of high school science and mathematics pre service and in service teachers" (Robinson 2). What the proposed course aimed to do was teach high school teachers about how to incorporate engineering principles into their high school courses. To determine the effectiveness of the newly designed curriculum, the study conducted pre and post tests on the teachers in the course. Those pre and post tests were then analyzed to determine if their efforts were a success. The study also looked at the results of one of the teachers who took the class the study was focused on. Taking what the teacher had learned

from the first class he then applied his knew knowledge in his lesson plans with high school students. The high school class was also given pre and post tests to ascertain their success. This particular study helped back up the aforementioned strategy by using pre and post tests as a way to gauge what the students had learned. The study also conducted its research and data analysis on two groups of people much like the team had planed to do in this project.

The second research paper that was read was titled "Speedy Switch". This paper dealt with technology education in an elementary school setting. The objective for the students was to construct an electric buzzer that incorporated a battery, switch, and buzzer. The way the students went about learning how to construct the circuit was to allow them to play with the components and learn how each component worked. After some students were able to construct the circuit, the class analyzed the activity to see how it worked. The students also learned concepts such as conductivity in this project. Ultimately, the way the material was presented to the student was to allow the students to perform the activity and use critical thinking skills to solve a problem. This method is similar to the method that was used during this project because the digital clock activity allows the students to work with actual electronic components to help them learn their respective functions.

The third paper that was analyzed was titled "High School Science Project-An Insight Into Engineering". This paper outlined an advanced robotics course that is used in some Israeli high schools. The class is very fast paced and is only available to great students. Although the class in this study is much more advanced than the class at Doherty there are some important similarities. A large part of each schools curriculum is similar. However, the Israeli schools curriculum is more in depth because their program is taught over the course of two school years. One characteristic that makes the Israeli school distinctive is its usage of numerous activities to reinforce the curriculum. Using an activity to reinforce concepts is what this project aimed to do as well. Ultimately, the team's goal was that the digital clock activity could incorporate the same critical thinking based learning that is found in the Israeli program.

First Group Activities and Lecture

Now that a plan of action had been established, it was time to begin the first trial. The first group of students to try out the activity consisted of 12 high school seniors. Everyone in the class had already completed the course in digital electronics the previous year. Over a four day period, the students worked on the digital clock. The first day was dedicated to introducing the lesson and the team's lectures. The following three days were dedicated to the construction of the digital clocks. Each day will be discussed in the proceeding sections.

Day One: Student Lectures and Pretest

As stated earlier, the first day was dedicated to introducing the students to the activity and teaching how the digital clock worked. All three lectures were presented in an hour and a half period. The digital clock prototype was brought into the classroom so the students could see what they would have to build and gain an appreciation for its construction. By looking at how the digital clock was built, the class was able to gain insight into how to organize and arrange their wireless breadboards before construction. The ability to map out a project and organize all of the electrical components present in a build of this magnitude was an important skill the teachers of Doherty Memorial High School had stressed throughout previous meetings.

Before the team's lessons, students were given 10 minutes to complete the pretest. Once the pretests were completed, they then listened to each lecture. Each team member was in charge of teaching one aspect of the digital clock. Every student had copies of the Microsoft Power Point slides and took notes during class. At the end of each lecture, a block of time was allotted to answering questions. Once everyone's questions had been addressed, the team then went over additional information that would be pertinent during their digital clock construction. Some of the material that was covered during this time dealt with talking about the network resistors that were used in the design, how a potentiometer works, and tips on how to read a schematic diagram of an electric circuit.

By examining the pre-tests, it was noted that almost every student got certain questions incorrect. One of the questions included calculating the capacitance in a 555 timer circuit. It was deemed important to address this problem and show the students how it was

solved. The team went over the question on the board to clear up any confusion. Additional tips were then given to conclude the day. One of the major tips that was shown to the students was how most engineers and scientist carry out calculations. It was suggested that the students solve the problem symbolically before plugging in the numerical values. This method would help eliminate algebraic mistakes.

Day Two: Timer Construction

During the second day, the digital clock construction began. Before the class started building, any additional questions that were not addressed the previous day were answered. Once each question was solved, it was time to begin building the digital clock. This day was dedicated to making the timer circuit that uses the 555 timer IC. The students were assigned into four groups consisting of three people. In the end, each group of students would construct one digital clock.

It took each set of students about 45 minutes to complete building the timer. During this period, the team visited with groups to observe how they worked with each other and to offer any additional assistance. However, the team provided little help because it was important the students troubleshoot their own problems. After each group of students was done completing their circuit construction, it was then time to look at their timer output waveform on the oscilloscope.

This part of the activity proved to be high in educational value. The school had a small number of oscilloscopes that were never used by the teachers and simply collected dust in the corner of the classroom. None of the students in the class had ever used an oscilloscope before. By the end of this activity, the students had an understanding of how to use an oscilloscope to test electric circuits. This is very important because oscilloscopes are an essential tool used by engineering students in college and engineers in their respective fields.

Now that the students were working with the oscilloscope, they then had to use more critical thinking. What they needed to do was find a way to slow down or speed up their output waveform to 1 Hz. To do this, they had to figure out that changing the resistance of the potentiometer would change the frequency of the output waveform. By the end of day two each group had constructed a timer circuit with an output of 1 Hz.

Day Three: One segment construction

The third day of construction was dedicated to building the first display in the digital clock. By the end of the period, each student would have half of a one minute digital clock completed. Their circuit would include the timer circuit they built the day before, and one segment that is able to count from 0 to 9, and then cyclically repeat the process over again. The students remained in the same groups as they were the day before. Construction went fairly smoothly and each group ran into fewer problems than they did the previous class. When the day ended, each set of students had completed the task in under an hour.

Day Four: Digital Clock Completion and Posttest and Questionnaire

The fourth day was the final day of our activity. This period was dedicated to finishing the digital clock. By the end of the class, each group of students had a fully functioning one minute digital clock. The build went fairly smoothly during this time. Each group was able to complete the project in the allotted time. Every clock that was constructed worked correctly. At the end of the build, each student took the posttest and filled out the final questionnaire.

Determining Activity Improvements

Now that the first group of seniors had completed the activity, the next objective was to recognize the project's weaknesses and make the necessary changes to improve the educational value of the laboratory. By taking what was learned from the first group of students, communicating with the faculty and students at Doherty, and analyzing the post test and student questionnaires, it was then possible to modify the activity to try to insure optimal educational value for the project's target group of students.

The first step that was taken during the improvement stage was to meet with the faculty at Doherty in December of 2006. The purpose of the meeting was to receive feedback from the teachers. What the team hoped to achieve was find ways to improve the educational value of the project, as well as relay any additional comments the students had shared with them about the activity. The first major piece of feedback that was discussed pertained to the lectures that were presented to them on day one. A major problem with the presentations was the overall clarity of the lectures in general. The students found certain

aspects of the lectures hard to understand. To deal with this problem the teachers offered their advice as well as comments the students had shared with them.

The first piece of advice was to cut down on the technical nature of the 555 timer lecture. Instead of focusing on the theoretical behavior of electrical components, the new lecture would focus on simple easy to follow diagrams and models. In the first set of presentations, the students were shown simplified schematics of the internal structure of the 555 timer. The students were then walked through how these electrical components work together to achieve the 555 timer's function. Because the 555 timer uses many components and several steps to achieve its desired output, a large portion of the students got lost and confused midway through the lecture. What the teachers suggested was incorporating a flow chart to allow the students to follow what was happening in the 555 timer. If a student was to forget a step or get lost they could simply refer to the flow chart to help clarify their confusion. An additional change that was made was to let each student know it was ok to ask questions during each lecture.

Extra material that was added to the 555 timer presentation talked about how a capacitor works when a voltage is applied to it. In electrical engineering this concept is known as a transient response. It was discovered in the first trial that the students did not have a conceptual understanding of how a capacitor behaved. In order for the students to completely understand the functionality of a 555 timer it was important for them to be taught this concept. A couple additional slides were added to the 555 timer presentation and a small block of time was allotted during lecture to cover this material.

One aspect of the 555 timer presentation that also needed clarification was the concept of an electrical comparator. A comparator is an electric device that is able to sense certain voltages. Once a comparator senses a voltage it is designed to sense the comparator will turn on. Once the voltage of the circuit goes below the value that the comparator is designed to sense the comparator will turn off. Because of a miscommunication with the teachers it was assumed that the students had an understanding of electrical comparators. However, due to time constraints the teachers were not able to cover that additional material. To address this problem, added time was allotted to the 555 timer lecture to cover this concept.

What was discovered from the first trial of students was the students understood what a comparator was; however, they had trouble grasping how the comparator plays a role in the function of a 555 timer. A way that was devised to teach the students how a comparator works in a 555 timer was to come up with what is known as an electrical model. Instead of thinking of the 555 timer circuit as a complicated circuit of resistors, capacitors, and comparators, the schematic was simplified by replacing the comparators with simple switches. This model that was devised was known as the “switch model”. What the switch model effectively does is allow the students to model a comparator as a simple switch. Instead of thinking of a series of comparators turning on and off they could simply think of these comparators as switches. The switch model was able to allow the students to understand on a more fundamental level how an electrical comparator works.

The second section in the team’s lectures dealt with the decade counter IC found in the team’s digital clock design. The problem that was encountered during the first trial with this presentation was the arrangement of the slides. The first major improvement that was made to this lecture was to reorganize the slides so they flowed in a more logical manner. To allow the students to see a decade counter, a picture of the counter was added to the slides.

What the team also discovered was the students often had a hard time understanding how the counter works because it takes the counter many steps to achieve its designed function. The driver must take an input digital signal and pass it through a series of internal logic gates to get a desired output. In the first series of lectures, students were exposed to a schematic explaining how each logic gate works together to achieve a desired output. During the first series of lectures the students were walked through this internal schematic too quickly for them to understand. To improve the student’s understanding, more time was allotted in the second presentation to discuss how the decade counter works internally. To give the students something to reference and study, a flow chart was created of all the steps a decade counter undergoes to achieve its function. In addition to the flow chart added to the presentation, a picture was added that illustrated how a decade counter is able to convert an input square wave into its desired output.

In the first set of lectures a supplemental website was added to the counter presentation to help show how a j-k flip flop works (citation). This particular website was accessed during the lecture and the students were walked through how the j-k flip flop operates. What was found to be a problem with this approach was the students had a hard

time understanding the activity when it was shown to them on a slide. The team did not want to omit this section because it was found to be a helpful exercise when learning about how a decade counter works. To fix this problem, instead of showing the students the activity during lecture we left it up to the students to investigate this website during their own time. By allowing the students to investigate the website alone the student would then be able to learn at their own pace and take their time to understand the concept. To insure each student visited the website and learned the material, a homework assignment was given to be completed the next day. The homework assignment was for each student to access the website and take part in the lesson. When they had completed the exercise, they then had to write a brief explanation of how the j-k flip flop works. The assignment was then handed in the next day and graded.

The third section of the teams lectures which dealt with the BCD driver and seven segment display. The teachers at Doherty communicated that the students understood this material fairly well in the first trial. However, there were still some mistakes and problems that needed to be addressed. One major mistake in this presentation was the pins of the seven segment display were labeled incorrectly on one of the slides. Because of this mistake when the first group of students were constructing their digital clock they referred to the slide and wired their digital clock incorrectly. To fix this, the pin orientation was simply corrected on the new set of slides.

The final adjustment made to this lecture was the addition of an exercise. The assignment was in the form of a worksheet with a couple of problems the students worked out in about 10 minutes. The intended goal of the activity was to further reinforce the concepts the students had just learned in the BCD driver and seven segment display lectures.

Second Group Activities and Lectures

After the proper improvements had been made to the activity, it was time for the second group of students to participate in the laboratory. During this trial, because of shortened class periods and a vacation, the students took much longer than the first group of students to complete the lab. The activity was held for 5 days before vacation. After vacation, the students resumed the project. It took the students a total of 7 school days after vacation to complete the laboratory. The sections that follow will outline these first five days where a large percentage of the students work was completed. There is also a section describing the seven days after vacation.

Day One: 555 timer and counter lectures



Figure 4.6: Introducing the 555 Timer to the class

The first day of this trial was dedicated to presenting the 555 timer and decade counter lectures. One important thing to note about the second trial was that the team was now working in a 43 minute timeframe as opposed to a 90 minute period seen in the first trial. The class period was held first thing in the morning as opposed to the last period of the day like in the first trial. These changes proved to be beneficial. The fact that the period was shorter allowed us to go over a smaller amount of material in one day. This proved to be helpful because the students in the first trial were simply overloaded with information during a ninety minute period. The fact that the class was held during the beginning of the day also proved to be helpful. During the first trial, the students seemed to be tired, as opposed to the second group of students who seemed to be aware. By the end of the day, both the 555 timer

and counter were covered. During each lecture and at the end of each presentation, time was allotted for the students to ask questions.

Day Two: BCD driver and seven segment display lectures

The second day was dedicated to teaching the students how the BCD driver and the seven segment display worked. Before the presentation started, the team went over a quick review of the material covered the day before. After that previous material was reviewed some time was allotted to allow the students to ask questions. After each student's question was answered, the presentation began. Because the presentation only took about 15 minutes to complete, there was a small amount of time left at the end of the period. To occupy this time, the students were given their electrical components and left to plan out their circuit. The team members visited with each group of students during this time to offer help, tips, and answer any additional questions.

Day Three: Beginning of 555 timer circuit construction

Now that the team's presentations had ended and the students had planned out their circuits the day before, it was then time to begin the activity. The third day was dedicated to the construction of the 555 timer circuit. As expected, none of the students were able to complete building the 555 timer circuit during the 43 minute period. By the end of the day most of the students had completed building $1/2$ to $2/3$ of the 555 timer circuit.

Day Four: Finishing the 555 timer circuit

Students spent day four completing their 555 timer. By the end of the period, each student team was able to complete their 555 timer circuit. Once each group finished building their circuit, it was then time for the students to begin using the oscilloscope to test their output waveform. Each student also had to figure out how to either slow down or speed up their output waveform. Every student was able to realize that using the potentiometer to adjust the resistance was the way to achieve this task. By the conclusion of day four, every student team's 555 timer circuit had a one Hz output square wave.

Day Five (Day Before Vacation)

Once the students completed their 555 timer circuit, they continued to work on building their clocks. However, none of them had a functional clock by the end of the week. At the end of this week the students had a week long vacation.

Week After Vacation

The week after vacation was dedicated to the students debugging and finishing their circuits. At the end of the laboratory the students received a final grade. If they had a fully functioning digital clock, they received an A. Any other grade that was given to the students was decided by their teacher and depended on how much they had built.

5. Results and Analysis

In this section of the report, the outcome of the digital clock activity will be discussed in detail. The team worked with two different groups of students. The first group was senior students, and the second group was junior students. We will first analyze the performance of each group on the pre-test and post-test. Secondly, all feedback, ideas and comments that we received from each group will be carefully reviewed. Finally, comparisons and conclusions will be drawn to reflect the activity's effectiveness,

5.1. First Group

The team carried out the activity with the first group of senior students who already took the digital electronic course in the previous year. A pre-test was given to the students on the first day of the trial prior to a sixty-minute long lesson presented by us on the same day. The students started the laboratory on the next following day. They had a ninety-minute long period of each day to work on the laboratory. The students spent four consecutive days on building the digital clock activity. A post-test was given on the day after the laboratory was completed. Additionally, each student also filled out an evaluation sheet, which gave us an opportunity to examine the effectiveness and the educational value of the digital clock activity.

5.1.1. Pre-test

The pre-test was constructed to test the fundamental knowledge of the students about the activity, which was about building a digital clock developed by us. The pre-test was taken by the students before the team presented the technical materials related to the activity. This allowed us to understand what the students previously knew and learned. In other words, the pre-test served as a tool to measure the digital electronics background of the students. The pre-test had eight questions, and the maximum score that could be obtained was 9.0. There were total twelve students took the test, and all of them were high school seniors. The mean score was 4.7 out of 9.0, and the median score was 5.0. This indicates that the first group of students had a certain level of knowledge about the materials of the activity. The results are shown in Table 5.1 and in Figure 5.1.

Table 5.1: First group pre-test

Pre-test	Score (Max score = 9)	Number of students
	1.0	1
4.0	2	
4.5	2	
5.0	3	
5.5	1	
6.0	1	
7.0	2	
Mean	4.7	
Total		12

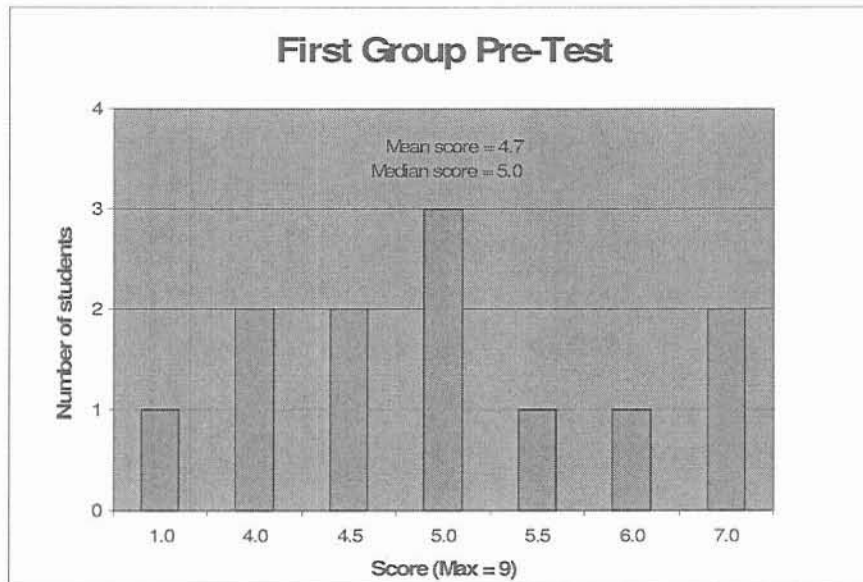


Figure 5.1: First group pre-test

Table 5.2 provides more information regarding the pre-test of the first group. There was 1 student who had the correct answer for question 6. Only 2 and 3 students answered correctly question 2 and 7, respectively. Question 2 asked the students to calculate the resistance by applying given equation. Question 6 was about BCD numbers, and question 7 was about the 74LS47 IC. The result indicated that most of students did not know how to compute a value of a parameter in a given equation. Many students did not have knowledge regarding 74LS47 IC and BCD numbers. The team expected that the students would do better on the post-test.

Table 5.2: First group pre-test details

Pre-test – 12 students		
Question	Number of Students had the right answer	Percentage
1	9	75%
2	2	17%
3	7	58%
4a	8	67%
4b	9	75%
4c	10	83%
4d	10	83%
5	11	92%
6	1	8%
7	3	25%
8	9	75%

5.1.2 Laboratory

The students were divided into four subgroups, each subgroup had three students. They began to work on the laboratory after our presentation. The digital clock activity comprised three main parts: constructing a timer circuit which would produce an electrical pulse every second, building a digital counter which would count from zero to nine, and building another digital counter which was able to count from zero to five. Upon completing these parts, the students would combine them together to create a digital clock which would count from zero to fifty nine every second cyclically; thus, the laboratory was named “One minute digital clock”.

The students needed four consecutive days to assemble the final circuit. The result did not quite satisfy the anticipation because two out of four teams could not get the digital clock to work. Unfortunately, we were unsuccessful in helping them debug the circuits because of the limited time. Some students expressed their frustration on their faces because of their non-working circuits. However, the students did show comprehension of the technical materials, reading the schematics, and assembling electronic circuits. At the end of the laboratory, the students were required to take a post-test which allowed us to evaluate their performances.

5.1.3 Post-test

The post-test was constructed in a similar fashion as the pre-test because we wanted to examine what the students gained and experienced from the activity. In other words, the post-test had the same type of questions. We expected the students to have a better performance on the post-test. The students took the post-test after completing the laboratory. The result is shown in Table 5.3, and in Figure 5.2.

Table 5.3: First group post-test

Post-test	Score (Max score = 9)	Number of students
	3.0	1
	4.5	1
	5.5	1
	6.0	1
	6.5	3
	7.5	1
	8.0	3
9.0	1	
Average	6.6	
Total		12

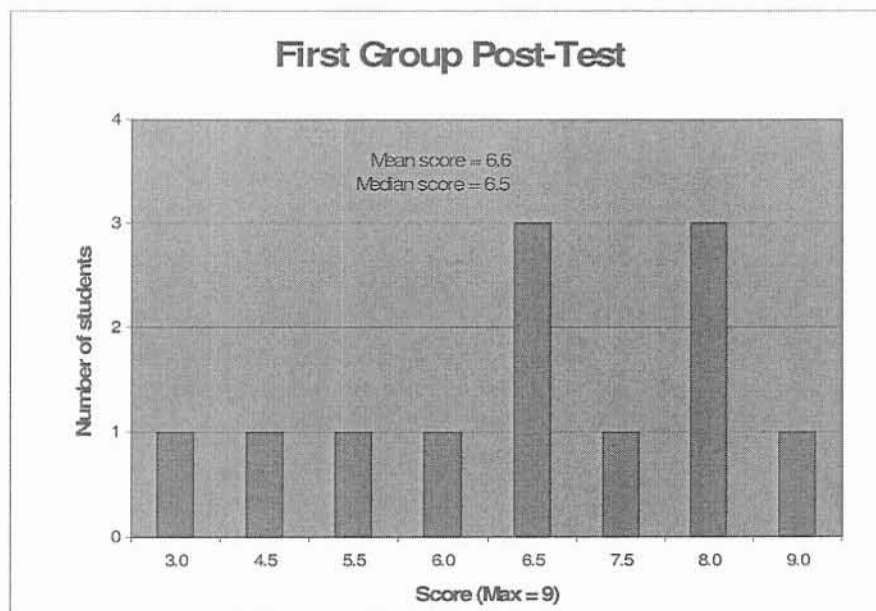


Figure 5.2: First group post-test

The mean score was 6.6 out of 9.0, and the median score was 6.5. Both values were greater than the corresponding values in the pre-test. Table 5.4 provides more information regarding the post-test of the first group. There were only 3 students who had the correct answer for question 3. This revealed that most of students still had difficulty in understanding the functionalities of 7490 IC. Overall, the result indicated that the first group showed comprehension of the materials in the activity.

Table 5.4: First group post-test details

Post-test – 12 students		
Question	Number of Students had the right answer	Percentage
1	11	92%
2	11	92%
3	3	25%
4a	11	92%
4b	9	75%
4c	12	100%
4d	12	100%
5	12	100%
6	12	100%
7	9	75%
8	8	67%

Table 5.5: Performance of each student in the first group

Student	Pre-test (Max score = 9.0)	Post-test (Max score = 9.0)
1	4.5	8.0
2	6.0	8.0
3	5.0	7.5
4	7.0	9.0
5	7.0	8.0
6	5.0	4.5
7	4.0	5.5
8	1.0	3.0
9	4.0	6.5
10	5.0	6.5
11	5.5	6.0
12	4.5	6.5

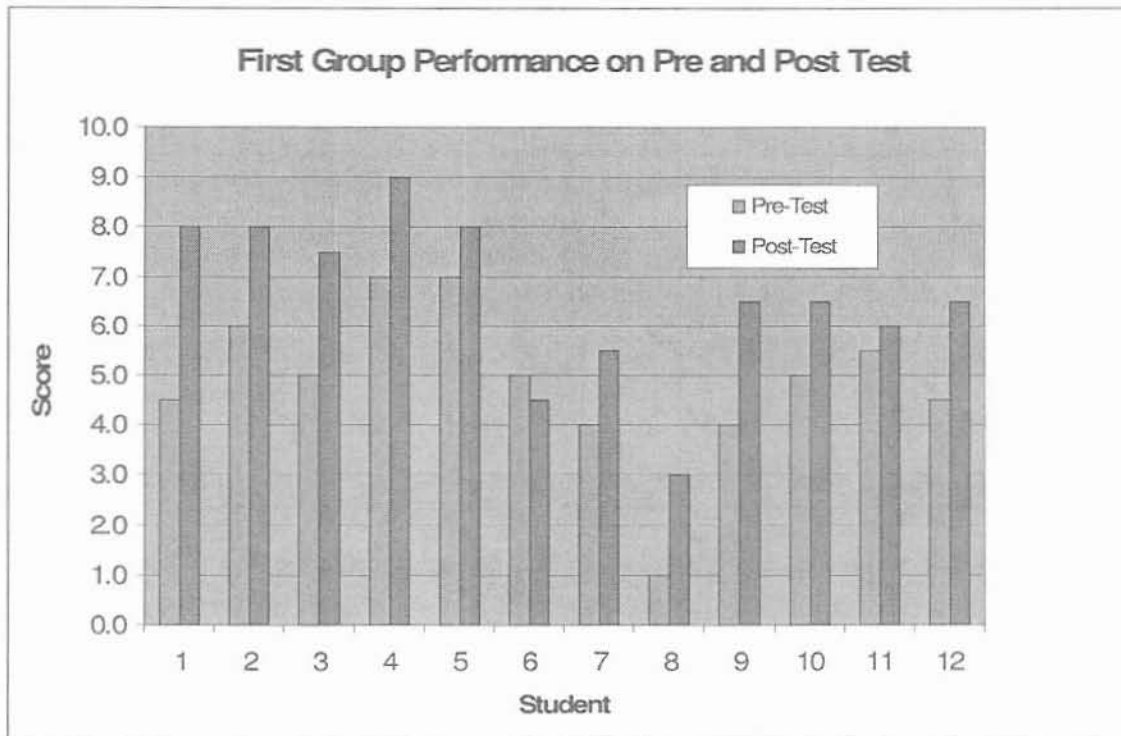


Figure 5.3: First Group Performance

Table 5.5 and Figure 5.3 allow us to observe the performance of each student on the pre-test and post-test. All students improved their scores on the post-test except the sixth student who had roughly the same score on two tests. We earlier concluded that students understood the materials of the activity because of the higher mean score of the post-test. Figure 8 confirms the aforementioned conclusion. In general, the first group of students performed well on the digital clock activity.

5.1.4 Feedbacks and Comments

Table 5.6: Feedback from first group

		Strongly disagree	Disagree	Agree	Strongly Agree
1	This overall activity has a high education value.	0%	0%	69%	23%
2	This activity improves your skills of assembling electronic circuits.	0%	8%	15%	77%
3	This activity improves your understanding about how to apply electronic principles in digital circuits.	0%	8%	85%	7%
4	This activity improves your understanding about the differences between analog and digital devices.	8%	15%	54%	15%
5	The lab instruction is easy to follow.	15%	29%	38%	8%
6	The lab instruction covers everything that you need to know to accomplish the task.	15%	38%	38%	8%
7	This activity improves your understanding about different digital devices. (i.e. 555 Timer, 7490 Decade counter, 7 segment Display and driver.)	0%	0%	69%	31%

Table 5.6 shows the percentage of the students responding to each question in the evaluation sheet. All the feedback and comments that the team received from the first group of students were certainly important and valuable. For instance, ninety-two percent of the students agreed that our digital clock was interesting and had a high educational value. The same amount of the students thought that the activity improved their skills of assembling electronic circuits, and enhanced their understanding about how to apply electronic principles in digital circuits. Sixty-nine percent of the students agreed that the activity improved their understanding about the differences between analog and digital devices. All of the students were sure that the activity improved their understanding about

different digital devices such as: the 555 timer, the 7490 decade counter, the 7-segment-display, and the 7447 BCD-to-7-segment-display driver.

On the other hand, forty-four percent of the students found that the laboratory's instructions were hard to follow. Noticeably, fifty-three percent of the students complained that the lab instructions were not detailed enough for them to accomplish the tasks. The team found that the actual circuit of our prototype was not consistent with the schematics. Therefore, this caused confusion among the students. All the negative feedback drove us to review carefully the lab instructions. We took into account the students' comments regarding our digital clock laboratory because this will allowed us to carry out the activity more effectively for the second trial.

5.2. Second Group

There were total 23 junior students in the second group. A pre-test was given to the students prior to the team's presentation. The team presented the lessons in two consecutive days. The students were given assignments at the end of each lesson. They started building the digital clock the following week.

5.2.1. Pre-test

The pre-test for this second group was the same as for the first group. Table 5.7 and Figure 5.4 show the pre-test results of the second group.

Table 5.7: Second group pre-test

	Score	Number of students
Pre-Test	2.5	4
	3.0	1
	3.5	1
	4.0	5
	4.5	2
	5.0	5
	6.0	3
	7.0	2
Average	4.5	
Total		23

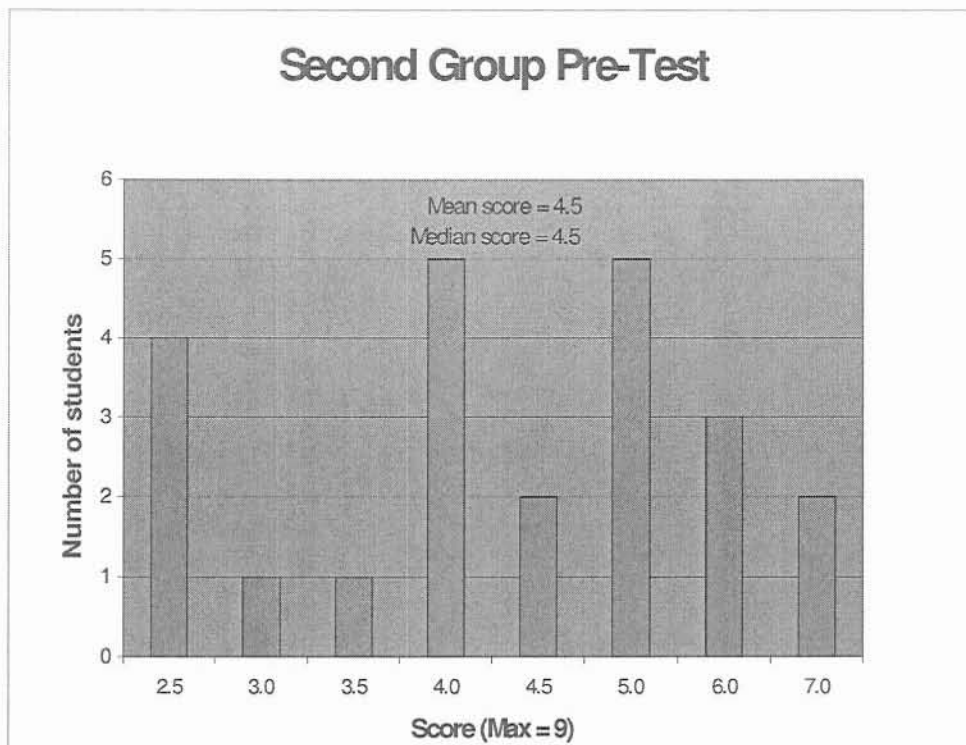


Figure 5.4: Second group pre-test

The mean score was 4.5 out of 9.0, and the median score was 4.5. The scores indicate that the second group of students also had some background regarding digital electronics.

Table 5.8: Second group pre-test details

Pre-test – 23 students		
Question	Number of Students had the right answer	Percentage
1	3	13%
2	10	43%
3	15	65%
4a	17	74%
4b	20	87%
4c	16	70%
4d	20	87%
5	18	78%
6	2	9%
7	7	30%
8	7	30%

Table 5.8 provides more information regarding the pre-test of the second group. It might be interesting to examine the number of students who had the right answer corresponding to each question in the test. Only student 2 and 3 answered question 1 and 6 correctly respectively. Question 1 asked the students about the functionality of the 555 timer IC, and question 6 was about BCD number. The result indicated that most of students did not have knowledge regarding 555 timer IC and BCD number. Both questions 7 and 8, had 7 students who answered correctly. That meant two third of students in the second group were not familiar with the 74LS47 IC. However, most of students were able to do other questions on the test. To make further conclusions, we had to wait for the post-test result.

5.2.2. Laboratory

The lab was started on January 22nd, 2007, and it was expected to end by the February 16th. However, because this second group had less experience and the students had a shorter class period, it took them several weeks to assemble the digital clock circuit. At the end of the laboratory, the students were required to take a post-test which allowed us to evaluate their performances.

5.2.3. Post-test

The second group of students took the post-test after their week long school break. Therefore, we did not expect them to have a good performance on the post-test because they might forget the material. The results are shown in Table 5.9, and in Figure 5.5.

Table 5.9: Second group post-test

Post-Test	Score (Max score = 9)	Number of students
	2.0	1
	2.5	1
	3.5	6
	4.5	3
	5.0	1
	5.5	3
	6.0	2
	6.5	1
	7.0	3
8.0	1	
Average	4.9	
Total		22

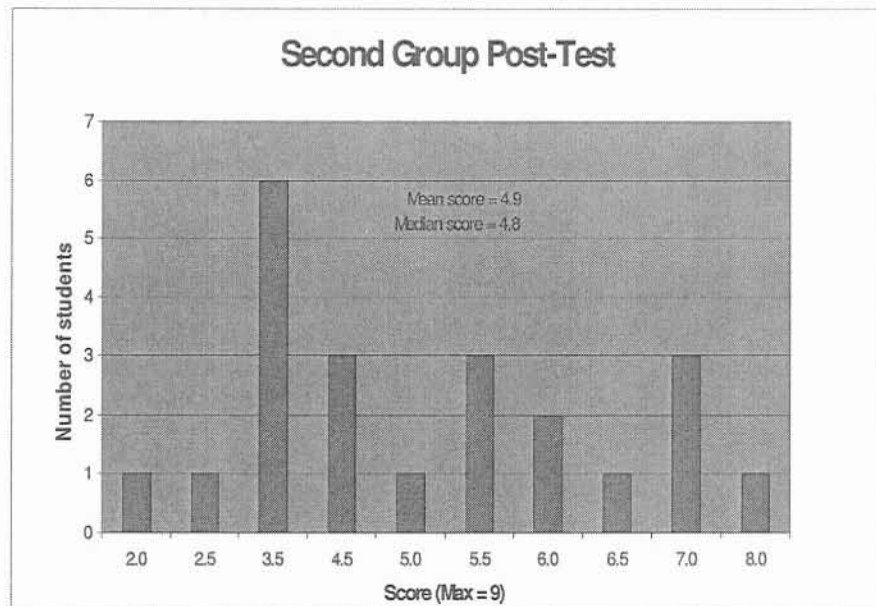


Figure 5.5: Second group post-test

The mean score was 4.9 out of 9.0, and the median score was 4.8. Both values were greater than the corresponding values in the pre-test. It should be noted that the number of students who took the post-test was one less than the number of students who took the pre-test. Table 5.10 provides more information regarding the post-test of the second group. There was only 1 student who had the correct answer for question 3. This revealed that most of students had difficulty in doing arithmetic.

Table 5.10: Second group post-test details

Post-test – 22 students		
Question	Number of Students had the right answer	Percentage
1	15	68%
2	8	36%
3	1	5%
4a	19	86%
4b	19	86%
4c	17	77%
4d	15	68%
5	10	45%
6	20	91%
7	11	50%
8	6	27%

Table 5.11: Performance of each student in the second group

Student	Pre-test (Max score = 9.0)	Post-test (Max score = 9.0)
1	4.0	5.5
2	2.5	3.5
3	5.0	5.5
4	5.0	7.0
5	4.5	4.5
6	7.0	6.5
7	6.0	7.0
8	4.0	3.5
9	2.5	2.0
10	5.0	8.0
11	7.0	3.5
12	6.0	7.0
13	6.0	5.5
14	4.5	4.5
15	5.0	4.5
16	4.0	3.5
17	3.0	3.5
18	3.5	2.5
19	2.5	3.5
20	4.0	6.0
21	2.5	5.0
22	5.0	6.0

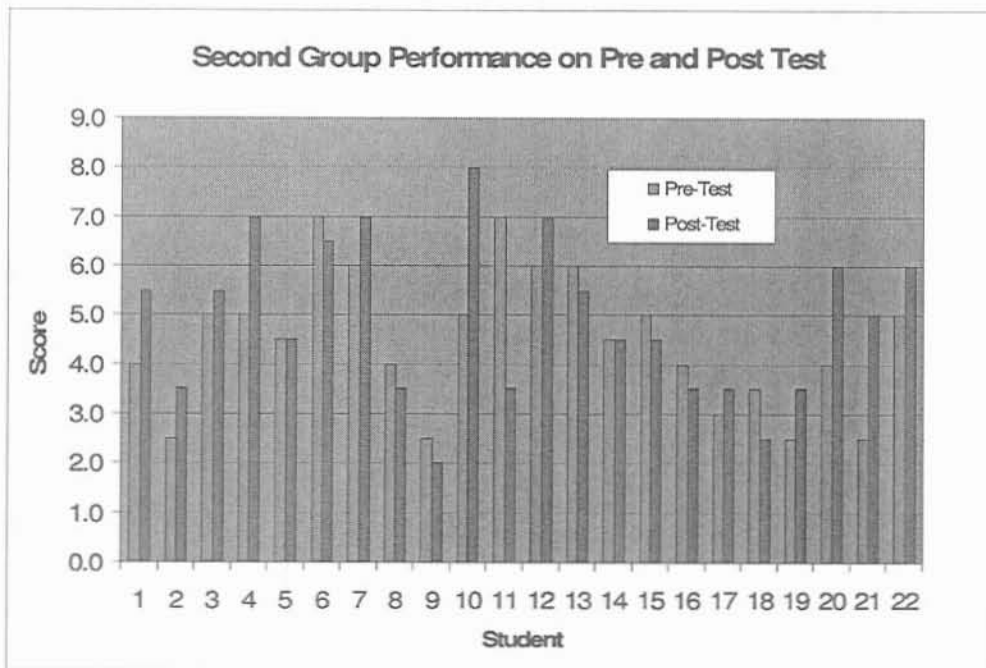


Figure 5.6: Second Group Performance

Table 5.11 and Figure 5.6 allow us to observe the performance of each student on the pre-test and post-test. Twelve students improved their score. Two students had the same score on both tests. The remaining students did not score higher on the post-test. It should be noted that the students took the test right after the school break. As we mentioned earlier, they might not remember the material. In addition, the students did not have a chance to review what they learned. Therefore, the team did not expect the second group to have a good performance on the test.

Table 5.12: Feedback from second group

		Strongly disagree	Disagree	Agree	Strongly Agree
1	This overall activity has a high education value.	0%	5%	77%	18%
2	This activity improves your skills of assembling electronic circuits.	0%	0%	55%	45%
3	This activity improves your understanding about how to apply electronic principles in digital circuits.	0%	0%	81%	19%
4	This activity improves your understanding about the differences between analog and digital devices.	0%	33%	52%	15%
5	The lab instruction is easy to follow.	6%	33%	50%	11%
6	The lab instruction covers everything that you need to know to accomplish the task.	0%	32%	50%	18%
7	This activity improves your understanding about different digital devices. (i.e. 555 Timer, 7490 Decade counter, 7 segment Display and driver.)	0%	13%	55%	32%

Table 5.12 shows the percentage of the students responding to each question in the evaluation sheet. All the feedback and comments that the team received from the second group of students were certainly important and valuable. For instance, ninety-five percent of the students agreed that our digital clock was interesting and had a high educational value. All students said that the activity improved their skills of assembling electronic circuits, and enhanced their understanding about how to apply electronic principles in digital circuits. Sixty-seven percent of the students agreed that the activity improved their understanding about the differences between analog and digital devices. Eighty-seven percent of the students were sure that the activity improved their understanding about different digital devices such as: the 555 timer, the 7490 decade counter, the 7-segment-display, and the 7447 BCD-to-7-segment-display driver. On the

other hand, thirty-nine percent of the students found that the laboratory's instructions were hard to follow. Thirty-two percent of the students complained that the lab instructions were not detailed enough for them to accomplish the tasks.

Although the team reviewed carefully and modified the laboratory after the first trial, the second group of students still seemed to have difficulty in following the instructions. The teachers said that the students had never had such a complicated project before. Therefore, they encountered problems when reading the technical information presented in the laboratory. However, most of students showed their interest in doing this digital clock activity.

6. Recommendations

There is an issue with the clock that can be easily recognized. The problem is that the digital clock always starts at 02 instead of 00 when it is connected to a 5V power supply. In other words, the counter that counts from 0 to 9 has an initial value of 2. The team did not mention this issue throughout the project nor find out the cause. In fact, it required the students to have a strong enough background of logic gates to understand this unexpected behavior of the clock. Moreover, because of the time constraint and the complexity, the team decided not to address the problem. Therefore, a thorough explanation and a technical solution are highly recommended. One way to initialize the clock is to add a button that resets the counter to 0 every time the clock is powered on. Another way is to first study carefully the inside logic diagram of the 7490 IC; then, make any necessary connections to set the initial value of the counter to 0. The aforementioned solutions are effective and straightforward. In the future, if the students have sufficient logic gate knowledge, this problem should be addressed and resolved.

7. Reflections

The First Run

After finishing the first lab, feedback and comments were collected from the teachers and the students. In the first run, the project's participants were a group of 12th grade students. After this group of students had completed the laboratory, they provided the team with feedback and comments. Ultimately, the team used this information to strengthen the project for the second group of students.

The lab successfully raised interest among the teachers and the students. Because this project uses a real world application of digital electronics, the students were able to appreciate its construction. One of the teachers had a plan to build on this activity in his lower level class. His plan was to modify the clock to countdown from 900 to 0. This clock could then be used as a count down timer in a manufacturing simulation activity. This motivated his class to finish the lab, and go beyond it.

The project proved to be an excellent way for students to work on an electrical engineering project and instantly see results by problem solving and hard work. Because the digital clock has a numerical display, it allowed the students to see the results instantly and directly. This established a clear goal for the students to work towards. Also, they could get an instant response if any changes were made on the circuit. This made debugging relatively easy and encouraged experimenting.

The activity successfully enhanced the knowledge and skills of the students and most of our objectives were achieved in the lab. According to the pre-test and the post-test, there was a significant increase in their test scores. The mean score of the tests had increased by more than forty percent. It indicated that the activity had strengthened their understanding of the course's material. Based on the survey collected, they agreed that their skills and knowledge had been enhanced. More than seventy-five percent of the students said the activity improved their skills of assembling electronic circuits, and more than eighty-five percent of them agreed that this activity improved their understanding about how to apply electronic principles in digital circuits. In conclusion, the first lab was successful and most of the objectives were achieved. However, there were some areas that required improvement.

There were some errors in the handout which had been given out. These errors included the schematic not matching up with the prototype, and wrong pin notation. These were not critical errors, because the participants could always refer back to the constructed prototype. However, all errors on the lab handout should have been corrected before giving them out to the students. The main reason of failing to spot these errors ahead of time was that the lab instructions were written after building the prototype. In the process of building the prototype, there were a number of modifications. A lot of changes had been made, and different adjustments on the prototype resulted in changes in the lab instructions. To avoid errors, a new prototype should have been made based on the lab instructions. Another flaw in the lab's instructions was the wording of the document was perhaps too technical and advanced for the students. Our team had spent a long time on the process of building the prototype, and all team members were familiar with the process and underestimated the difficulty of building a digital clock. This resulted in vagueness in some areas in the lab instructions.

The students did not fully understand the concepts that had been covered. Concepts and the clock mechanism of the lab had been introduced to the students before they started working on the lab. From the feedback received, the students had difficulties understanding the topics that had been covered. One of the most important causes was the complexity of the materials. Some of the concepts we had covered were college level. Even though they had been simplified, they were still difficult. A lot of background knowledge was required in order to fully understand the material. In order to solve this problem, better pacing was needed. More time should have been allocated to the sections which were more complicated. Also, using symbolic diagrams such as flow charts would help to convey the idea better. The level of detail should have also been adjusted so the class could understand the logic without tracing through unnecessary details.

There are always differences between the school environment and the real world. One of our lab objectives was to do something practical and solve real world problems, so some of the documentation and materials in the lab were from the industry, and they were in industry format. For example, the schematics were in an industrial standardized format. The students found them too difficult to understand and work with. In order to

make them adapt more smoothly, more emphasis should have been made on understanding the industry standards.

Based on the feedback of the first run, the strengths and weaknesses of the lab were discovered. The decision of using a digital clock as an activity was correct, because it had successfully captured the students' interest, and the lab had strengthened their knowledge. The weaknesses of the lab had also been exposed, and they could be fixed. With these modifications, a bigger success on the second trial was expected.

The Second Run

The first run gave us valuable experience and it helped improve the lab. Based on the comments from the students and the teachers, more symbolic graphs were added to help students visualize the ideas. The team's presentations became more effective, and the new group of students understood the concepts better.

The second run was done with a new group of 11th grade students. They had less experience with building prototypes. They struggled with the layout of the circuit a lot, because they did not organize the components well. Many jumper wires crossed each other, and some of the students put the components too close together. These made it hard to understand the circuit and made debugging difficult. Therefore, it took more time for them to finish the lab.

There was a time constraint. The 11th grade students had a shorter class period which was about fifty minutes. In each class period, students needed to spend time to pick up where they left off in the previous class. This was not very effective, because they were spending more time recalling what they had done, compared to the students in the first run. In order to shorten the picking up period, they wrote down what they had done on the circuit at the end of every lab. Besides the problem of a shorter class period, there was a time constraint on the overall project period. The second lab was started on January 22nd, 2007, and it was expected to end by the February 16th. This assumption was made based on the first run. The first group of students finished their lab in about three weeks, so the second group was expected to finish the lab within four weeks. However, because they had less experience and they had a shorter class period, it took them more than four weeks to finish the lab. It extended the length of the lab because they had a

school break between February 19th and 24th. They needed to spend more time to recall their progress after the break. The time constraint slowed down the progress of the lab.

The lab should have been broken into smaller sections. A digital clock circuit was the most complicated circuit that the second group of students had worked on. It was a big step for them to build a digital clock from scratch. They were given a lot of information at once, and some of them found that the information was too much and confusing. They commented that it would be easier for them if the lab was divided into three smaller units. The 555 timer circuit should have been introduced first. Immediately after the students had learned about the circuit, they would then construct it and test it using the oscilloscope. The second part could have been the counting circuit, and the display of the clock could have been introduced last. They felt that the lab would be more manageable if presented in that fashion. Taking smaller steps at a time could make the process of building the clock easier.

The lab challenged the students to think of their own solution. Unlike all the projects that this group of students had done, this lab required them to be creative in order for them to finish. The schematic of the clock was given to the students, but the students needed to construct it in their own way. They experienced a lot of problems when building the circuit, because they were unable to make it in a way which was easy to understand and debug. In this project, they learned the importance of organization and planning. Some of them reconstructed the whole circuit, so they could debug more easily. It was an educational lab for them, because they learned to think of different approaches to achieve a goal.

Overall, the lab was successful. It was challenging and interesting. The students were involved, and they were satisfied when they completed the lab.

8. Conclusions

Once the entire project was completed, the team met with the teachers of Doherty Memorial High School to discuss the outcome and effectiveness of the digital clock activity. They communicated that the students found the lab interesting and educational. One aspect of the project the teachers particularly liked was the challenge it gave students. As one teacher said “this project effectively pushed students to the boundary of their current abilities, and forced them to use critical thinking”. The laboratory taught students the importance of organization during a project of this magnitude. Overall the teachers were pleased and felt it was a valuable learning experience.

One major goal was to prepare students for college level project work. This goal was met because the activity was more complicated than any previous activities they had ever participated in. The complexity of the lab taught students to incorporate a variety of problem solving skills, use creativity, organize information, and work as a team to accomplish a difficult task. All of these abilities that the team hoped the students learned during the course of this project are essential for succeeding in college. Another major goal was to have students exposed to real world applications of digital electronics. This goal was successfully achieved since the digital clock is a widely used device. By constructing a practical device, the students were able to see how digital theories could be implemented in everyday life.

To conclude, this project was a rewarding experience for both the team and the students at Doherty Memorial High School. The students understood the importance of being concise and consistent in the engineering field. The team learned how to develop a laboratory, manage time, and organize a large scale project effectively. The team hopes that educators are able to learn from our work and benefit from our efforts to advance high school engineering education.

Appendix Overview

Appendix A1 - Lesson Plan

This appendix provides a lesson plan for introducing the digital clock to the students.

Appendix A2 – Activity Plan

This appendix is a plan for carrying out the digital clock activity.

Appendix A3 – Lecture Slides

There are three sets of PowerPoint slides in this appendix. The first set of slides covers the functionality of a 555 timer circuit. The second set of slides introduces the 7490 counting circuit. The last set of slides consists of the logic of building an integrated circuit, and how they are related to the display component of a digital clock.

Appendix A4 – Manufacture Datasheets

This appendix is provided as a reference for people who would like to have a better understanding of the ICs that are being used in the digital clock activity. The manufacture's data sheets of 555 Timer IC, 7490 IC, 74LS47 IC and 7-segment LCD display can be found in this appendix.

Appendix A5 – Lab Instructions

The appendix is a complete laboratory which provides instructions for building a digital clock in detail.

Appendix A6 – Material List

Appendix A7 – Pre-test

The pre-test serves as a tool for measuring the digital electronics background of the students.

Appendix A8 – Post-test

The post-test is used to measure the effectiveness of this laboratory. It is designed to be taken by students after completing the activity.

Appendix A9 – Evaluation

This form is given out to students to collect comments regarding the laboratory. The collected data will allow the teachers to perform enhancements and make modifications in order to maximize learning benefits for the students.

Appendix A1 – Lesson Plan

Title Lesson: Ever Wonder How Digital Clocks Work?

Grade Level: 11 - 12

Time Required: 60 minutes

Keywords: digital, clock, digital clock, digital electronic, timer, decade counter, design

Summary: Students are introduced to four main components of a simple digital clock. Each component is going to be discussed in terms of its basic functionality and its typical application. Students have an opportunity to explore the digital world by participating in constructing digital clock activity which ultimately provides them knowledge of digital practical applications and enhances their understanding of digital technology.

Engineering Connection: Digital electronics is an important field in which engineers have been exploring, inventing and creating numerous applications that have made our world a better place to live. Introducing digital electronics early in secondary schools helps students develop interest in digital technology and understand the significant impacts of engineering.

Related Curriculum

Activity

[One Minute Digital Clock](#)

Educational Standards

- Massachusetts Technology/ Engineering: 5.1, 6.2
- Massachusetts Vocational Technical Education Framework (Manufacturing, Engineering, and Technology Cluster Electronics): 2G, 2AA, 2BB, 2CC

Pre-Requisite Knowledge

- Basic understanding about logic gates: AND, OR, NAND, NOR.
- Be able to construct truth tables for these logic gates.
- Be able to convert between binary and decimal.
- Basic knowledge about capacitors, diodes, resistors, transistors, voltages, currents, Ohm's Law, flip-flops, digital circuits.

Learning Objectives

After this lesson, the students should be able to:

- Understand the basic functionalities of several ICs: the 555 timer, the 7490 decade counter, and the 74LS47 BCD to 7-segment LCD display driver.
- Perform computations to obtain resistance, capacitance, and frequency by applying related given formulas or equations.
- Implement the aforementioned ICs to build a digital circuit.

Introduction / Motivation

The digital clock is a very important device. Not to mention that it can wake you up in the morning. Many modern electrical devices, such as microwaves, washers, air conditioners, and computers have a built-in digital clock. The digital clock has become an indispensable device and people have been using it in many different ways. This lesson teaches students the main components used to construct a digital clock.

Lesson Backgrounds & Concepts for Teachers

Three out of four components of a digital clock are Integrated Circuits (IC) : the 555 timer, the decade counter 7490, and the BCD 7-segment LCD display driver. The last component is 7-segment LCD display. Figure A1.1 shows the 4-module block diagram of a digital clock.

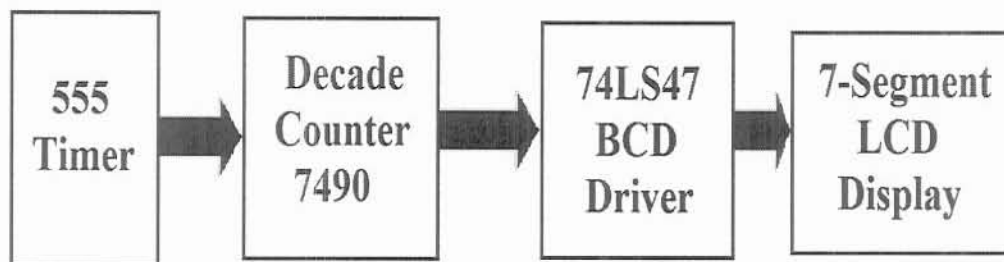


Figure A1.1: Digital clock block diagram

The first module provides a timing mechanism by producing a 1Hz square wave. In other words, the 555 timer circuit produces an electric pulse every second. The second module takes the 1Hz square wave as input and generates 4 outputs. Each output is either 5 Volts or 0 Volts. In addition, each output can be interpreted as either high – 1 or low – 0. The outputs represent 4 bits of a binary number that has corresponding decimal value ranging from 0 to 9. The third module simply takes 4 outputs of the decade counter 7490 and generates 7 outputs – either 5 Volts or 0 Volts – which are then utilized to control the segments of the 7-segment LCD display in the last module. The segments of the LCD display are LEDs that work together to display a numerical value. That is the fundamental internal operation of a digital clock.

The Appendix A3 contains lecture slides which are presented by the teachers in order to provide the students with fundamental and essential knowledge regarding the digital clock laboratory. There are three main lectures with the following titles:

- 555 Timer Circuit
- Decade Counter 7490

- 7-Segment Display Circuit

The Appendix A4 contains manufacturers' datasheets of four main components. These data sheets are references for the teachers, but they can also be used by the students to gain greater understanding about the ICs. The datasheets are for the following components:

- 555 Timer IC
- 7490 IC
- 74LS47 IC
- 7-segment LCD display

The following sections discuss in detail each module specified in figure A1.1.

First module: 555 Timer IC

The first module, the 555 timer, is an integrated circuit that produces a 1Hz signal at the output pin 3 in figure A1.2.

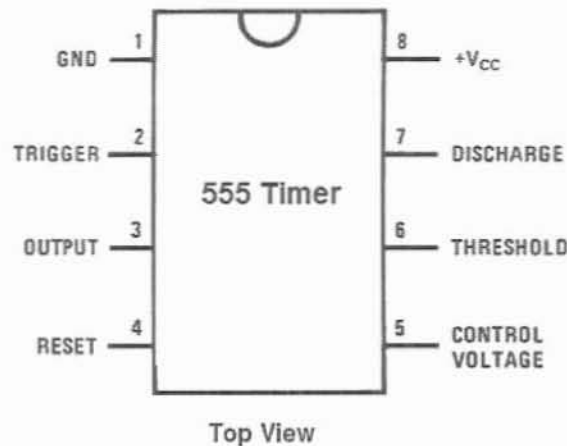


Figure A1.2: Overview 555 timer

There are some external electronic passive components such as resistors and capacitors associated with the 555 timer IC. The external components determine the frequency of the output signal because the frequency is computed by the following equation:

$$f = \frac{1}{0.693 \cdot C \cdot (R1 + 2 \cdot R2)} \quad (\text{Equation 1})$$

The parameter f in the above equation represents the frequency of the output signal. The parameter C is the capacitance, and the resistances are represented by $R1$ and $R2$. Figure A1.3 depicts the 555 timer circuit in which the above parameters are illustrated.

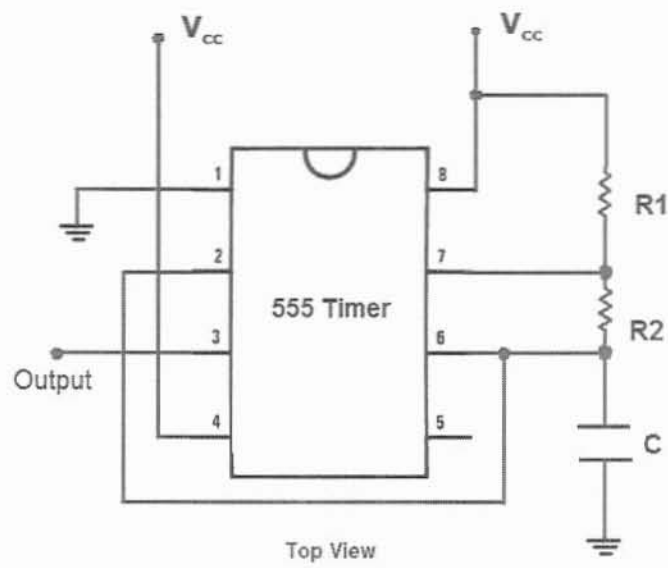


Figure A1.3: The 555 timer circuit

Capacitance C is often chosen to be $100\mu\text{F}$. By choosing appropriate values for $R1$ and $R2$, a desired frequency can be obtained. In general, the first module provides a timing mechanism for the digital clock.

Second module: Decade Counter 7490

The second module, the decade counter 7490, is an IC which is depicted in figure A1.4. This IC counts the number of electrical pulses arriving at the input pin 1. The number of pulses counted will appear in binary form on four output pins: 8, 9, 11, and 12. It should be noted that the 7490 IC can only count from zero to nine in decimal value. When the tenth pulse arrives at the input, the binary output is reset to zero, and the IC starts counting from zero.

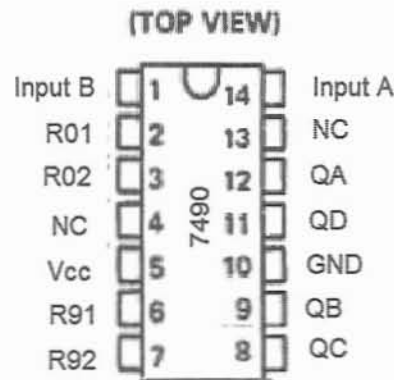


Figure A1.4: Decade counter 7490 IC

The outputs are QA, QB, QC and QD which are 4 bits in a binary number. QA is the least significant bit (LSB), and QD is the most significant bit (MSB). Table A1.1 shows the 7490 IC's binary outputs and the corresponding decimal values.

Table A1.1: Outputs of decade counter 7490

QD	QC	QB	QA	Decimal
0	0	0	0	0
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
0	1	1	0	6
0	1	1	1	7
1	0	0	0	8
1	0	0	1	9

Third module: 74LS47 BCD Driver

The third module is also an IC which is depicted in figure A1.5. We discussed earlier that the 7490 IC in the second module had four output pins corresponding to four bits of a binary number. This binary number gives a decimal value ranging from zero to nine. The 74LS47 IC takes the 4 outputs of the 7490 IC and converts them to 7 outputs. The 4 input pins of the 74LS47 IC are 1, 2, 6 and 7. The 7 output pins were 9, 10, 11, 12, 13, 14, and 15.

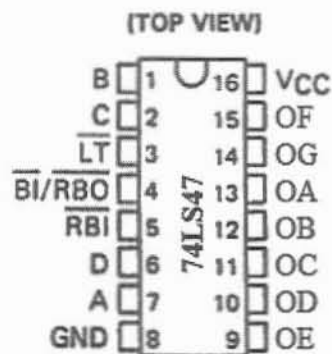


Figure A1.5: The 74LS47 IC

Fourth module: 7-segment LCD Display

The last module is the 7-segment LCD display and it receives signals from the 74LS47 IC's output pins. The internal LEDs of the 7-segment LCD display will be lit up depending on the signals coming from the seven outputs of the 74LS47 IC. If the coming signal is high or 5 Volts, then the corresponding LED will be turned on. In contrast, if the signal is low or zero Volts, then corresponding LED will be turned off. Figure A1.6 depicts the 7-segment LCD display.

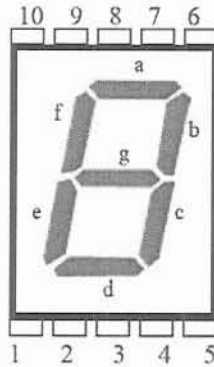


Figure A1.6: 7-segment LCD display

Vocabulary / Definitions

BCD: Binary Coded Decimal.

BJT: Bipolar Junction Transistor is a type of transistor.

Digital electronics:

LCD: Liquid Crystal Display.

LED: Light-emitting Diode is a semiconductor diode that emits light when conducting current.

Associated Activities

- One Minute Digital Clock: students apply materials learned from the lesson to build a digital clock that runs from 0 to 59 seconds cyclically.

Lesson Closure: In this lesson we learned the basic structure and fundamental operation of a digital clock. We understood how digital theories are applied to create practical applications. We are now familiar with several ICs: 555 timer, decade counter 7490 and 74LS47 BCD driver. Can you describe what the 555 timer circuit does? (Answer: it produces square wave, or electric pulses, or oscillation.) What does the decade counter 7490 IC do? (Answer: It counts from zero to nine cyclically.) What is used to display a number? (Answer: 7-segment LCD display.)

Assessments

Pre-Test (Refer to Appendix A7)

The teachers should ask the students to take this pre-test before starting the lessons. The results of this test will reveal the level of the students' knowledge prior to the lessons.

Post-Test (Refer to Appendix A8)

The teachers should ask the students to take this post-test after completing this project. The results will reveal the students' understanding regarding the materials presented in the project.

Evaluation Sheet (Refer to Appendix A9)

This evaluation sheet is optional. The sheet can be filled out by the students after they finish the post-test. The collected data will allow the teachers to perform enhancements and make modifications in order to maximize learning benefits for the students.

Attachments

Appendix A3 – Lecture Slides

- 555 Timer Circuit
- 7490 Counting Circuit
- Seven-Segment Display Circuit

Appendix A4 – Manufacture Datasheets

- 555 Timer
- 7490 Decade Counter
- 74LS47 BCD driver
- 7-segment LCD Display

Appendix A5 – Lab Instructions

Appendix A6 – Materials List

Table A1.2: Material List

Quantity	Item
1	555Timer IC
2	Decade Counter 7490 IC
2	BCD Driver 74LS47 IC
2	Common Anode 7-segment Display
2	Network resistor 390 ohm
1	Potentiometer
2	Resistor 2k Ω
1	Capacitor 100 μ F
1	Breadboard with 5volt Power Supply
50	Wires (each around 2 inch long)
1	Multi-meter
1	Oscilloscope

Appendix A7 – Pre-test

Appendix A8 – Post-test

Appendix A9 – Evaluation

Reference

Appendix A2 – Activity Plan

Title Activity: One Minute Digital Clock

Grade Level: 11 - 12

Time Required: 240 minutes

Keywords: digital, clock, digital clock, digital electronics, timer, counter, design

Summary: In this activity students will be constructing a two digit digital clock that counts from 0 to 59 every second cyclically. The students will have a chance to work with different integrated circuits (ICs), such as the 555 timer, the 7490 decade counter, and the 74LS74 BCD to 7-segment LCD display driver. They will also be experiencing many electronic components such as potentiometers, resistors, network resistors, electrolytic capacitors, and LED displays. Ultimately this project will allow the students to apply their knowledge of digital electronic to solve a practical application and gain a better understanding of digital technology.

Engineering Connection: This activity connects to modern real world engineering by allowing the students to work with electrical components and devices such as the oscilloscope, DC power source, and multi-meter. All of them are used everyday by electrical engineers. The students will be exposed to a practical digital electronic application in which they will be able to see what engineers design and create, specifically what electrical engineers do, to make our world better.

Related Curriculum

Lesson [Ever Wonder How Digital Clocks Work?](#)

Educational Standards

- Massachusetts Technology/ Engineering: 5.1, 6.2
- Massachusetts Vocational Technical Education Framework (Manufacturing, Engineering, and Technology Cluster Electronics): 2G, 2AA, 2BB, 2CC

Pre-Requisite Knowledge

Students are required to understand the lesson “Ever Wonder How Digital Clocks Work?” before carrying out this activity.

Learning Objective

After this activity, the students should be able to:

- Understand digital electronics better.
- Assemble electronic circuits.
- Use skillfully digital instruments: multi-meter, oscilloscope, and potentiometer.

Materials List

Table A2.1: Material List

Quantity	Item
1	555 Timer IC
2	Decade Counter 7490 IC
2	BCD Driver 74LS47 IC
2	Common Anode 7-segment Display
2	Network resistor 390 ohm
1	Potentiometer
2	Resistor 2k Ω
1	Capacitor 100 μ F
1	Breadboard with 5volt Power Supply
50	Wires (each around 2 inch long)
1	Multi-meter
1	Oscilloscope

Introduction / Motivation

Have you ever wondered how digital clocks work? Have you ever attempted to construct a digital clock? In this activity, you are going to build your own digital clock that is able to time 1 minute. Let's get started.

Procedure

The Appendix A5 is a complete laboratory which provides instructions for building a digital clock in detail. The teachers should go through the entire procedures with the students before carrying out the activity.

Attachments

Appendix A3 – Lecture Slides

- 555 Timer Circuit
- 7490 Counting Circuit
- Seven-Segment Display Circuit

Appendix A4 – Manufacturer's Datasheets

- 555 Timer
- 7490 Decade Counter
- 74LS47 BCD driver
- 7-segment LCD Display

Appendix A5 – Lab Instructions

Appendix A6 – Materials List

Appendix A7 – Pre-test

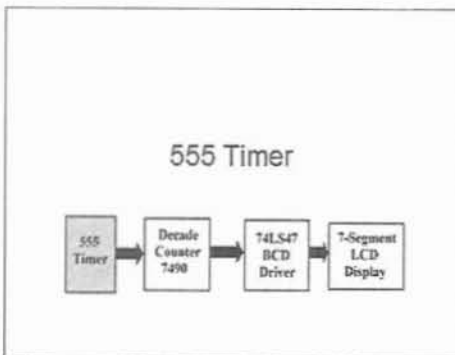
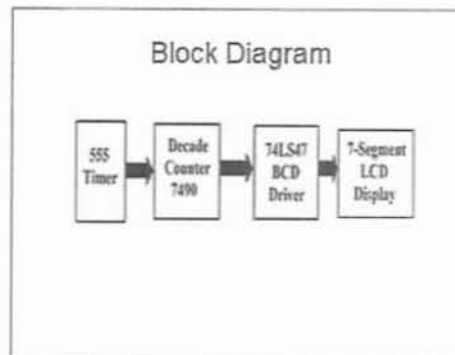
Appendix A8 – Post-test

Appendix A9 – Evaluation

Reference

Appendix A3 – Lecture Slides

Lecture Slide Show – 555 Timer Circuit



About 555 Timer

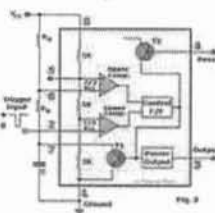


- 8 Pin Chip
- Invented in 1971
- Still widely used today
- We will be using this integrated circuit to create an output square wave.

What is inside the 555 Timer?

- The inside of a 555 timer is a complicated circuit composed of 20 transistors, 15 resistors, and 2 diodes that work together to convert a DC voltage source to an square wave.
- We will take a look at a simplified version of a 555 timer to help gain an understanding of how it works.

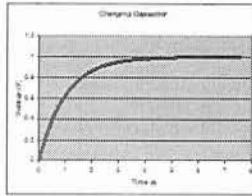
Simplified 555 Schematic



- 1 The comparators seen in the schematic act as voltage sensors.
- 1 By sensing certain voltage these comparators cause the capacitor to charge and discharge.
- 1 So how does the 555 timer do all this???

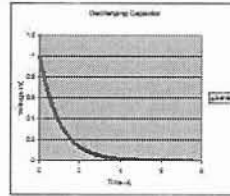
Lecture Slide Show – 555 Timer Circuit (continued)

First A Really Quick Capacitor Review



- When a voltage is applied to a capacitor with an initial voltage of zero at time zero the voltage across the capacitor will charge exponentially until it reaches the source voltage.
- The voltage vs. time graph can be seen in Figure

Quick Capacitor Review Continued

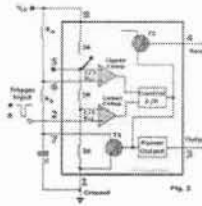


- When a capacitor is made to discharge its voltage will exponentially decay to zero.
- The voltage vs. Time graph can be seen in the figure

Step by Step Operation



Switch Model



Charging capacitor charges until its voltage reaches roughly 2/3 the source voltage we will say our switch is CLOSED using this step.

The 2/3 comparator turns on discharging the capacitor until it reaches 1/3 the value of the source voltage. We will say our switch is now OPEN.

The 1/3 comparator senses when its voltage is slightly below 1/3 the value of the source voltage. At this point our 1/3 comparator will turn on and again we can say our switch is CLOSED.

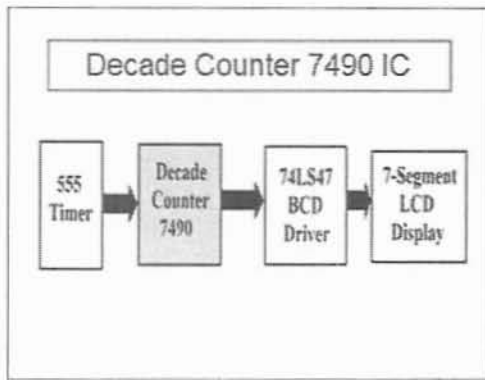
The whole process is repeated again. Essentially the 555 timer just causes a switch to open and close which means a capacitor discharge and charge. Simple!

Saw-Tooth Signal

- So how does the 555 Timer turn a saw-tooth signal into a square wave?
- As we said earlier the 555 timer is made up of many more components than the ones we covered today. Those components work together to convert the saw-tooth into a square wave.

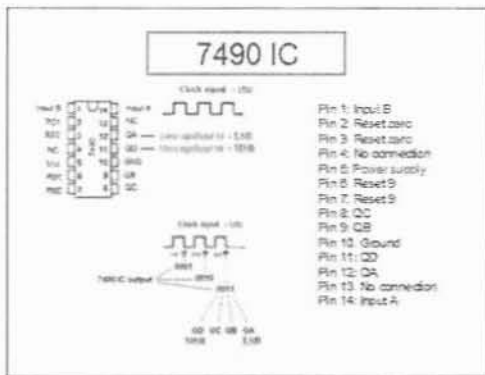
Any Questions??

Lecture Slide Show – 7490 Counting Circuit



Decade Counter 7490 IC

- Transistor-transistor logic IC
- 14-pin chip
- Be able to count from 0 to 9 typically and can count from 0 to any number less than or equal to 9



What is inside the 7490 IC?

- JK Flip-Flops
- Additional logic gates

JK Flip Flop

J	K	Q _{next}	Q _{prev}
0	0	Q	Q
0	1	0	1
1	0	1	0
1	1	X	X

<http://www.electronics-tutorials.ws/flip-flop/jk-flip-flop.html>

Logic Diagram

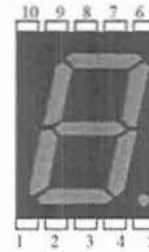
QD (MSB)	QC	QB	QA (LSB)	Count (Decimal)
0	0	0	0	0
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
0	1	1	0	6
0	1	1	1	7
1	0	0	0	8
1	0	0	1	9

Lecture Slide Show –Seven-Segment Display Circuit

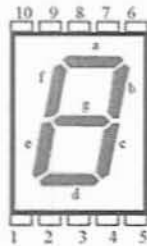
BCD Driver and Seven Segment Display

Seven Segment Display

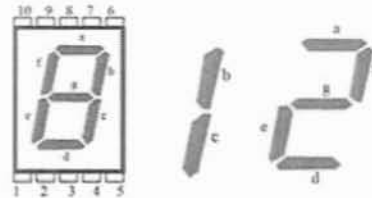
- 10 pin
- Take 7 inputs
- Anti-clockwise layout



- One pin controls one segment
- Example:
- Pin6 controls segment a
- Pin7 controls segment b
- Pin9 controls segment f



- To Display '1', only segment b and c should be on
- To Display '2', only segment a, b, d, e, g should be on



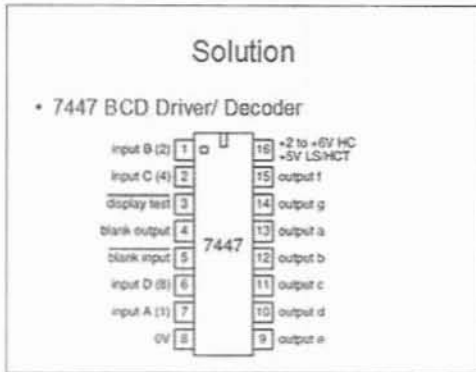
Decade Counter 7490 Output

QD MSB	QC	QB	QA LSB	Count (Decimal)
0	0	0	0	0
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
0	1	1	0	6
0	1	1	1	7
1	0	0	0	8
1	0	0	1	9

Problem

- 7490 Decade Counter produces 4 outputs
- Seven Segment Display takes 7 inputs
- It doesn't match!!!

Lecture Slide Show –Seven-Segment Display Circuit (continued)

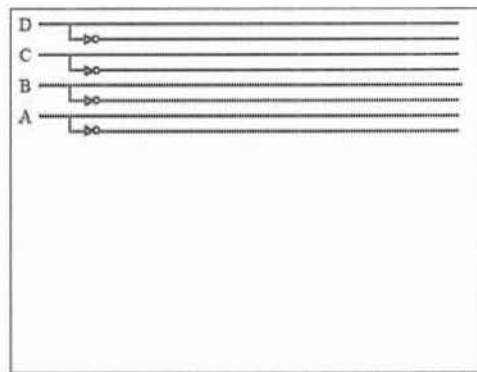
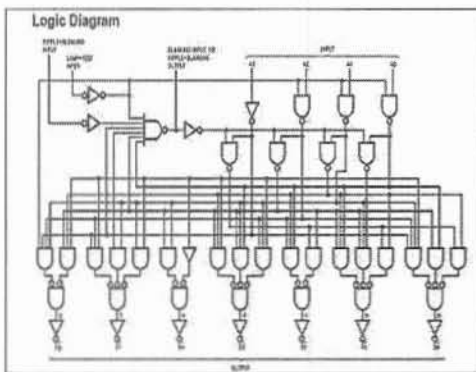


- ### 7447 BCD Driver/ Decoder
- 16 pins
 - Takes 4 inputs
 - Produces 7 outputs
 - BCD = **Binary-coded decimal**
 - 4 bit to represent a digit
 - One = 0001
 - Two = 0010

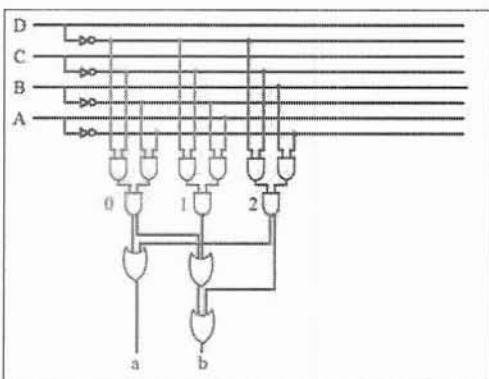
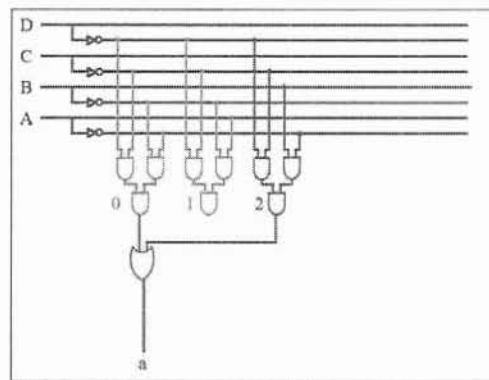
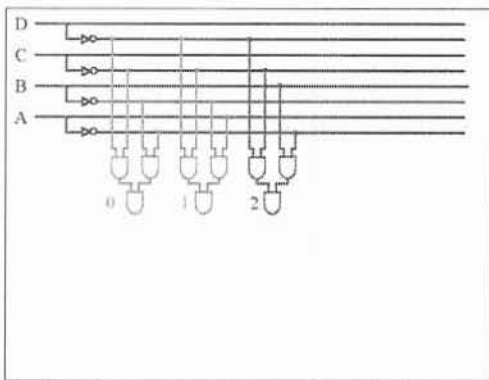
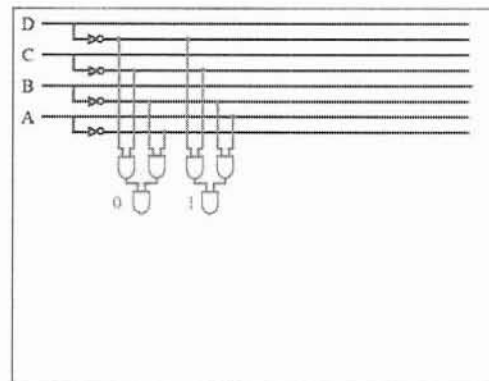
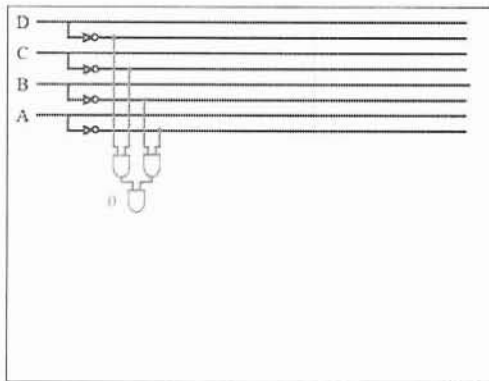
7447 Input and Output

Decimal Value	4 Inputs (BCD form)	7 Outputs
0	0000	1111110
1	0001	0110000
2	0010	1101101

How?

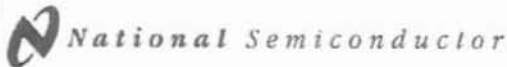


Lecture Slide Show –Seven-Segment Display Circuit (continued)



Appendix A4 – Manufacturers' Datasheets

555 Timer Manufacturer's Datasheet



March 1997

LM555/LM555C Timer

General Description

The LM555 is a highly stable device for generating accurate time delays or oscillation. Additional terminals are provided for triggering or resetting if desired. In the time delay mode of operation, the time is precisely controlled by one external resistor and capacitor. For astable operation as an oscillator, the free running frequency and duty cycle are accurately controlled with two external resistors and one capacitor. The circuit may be triggered and reset on falling waveforms, and the output circuit can source or sink up to 200 mA or drive TTL circuits.

Features

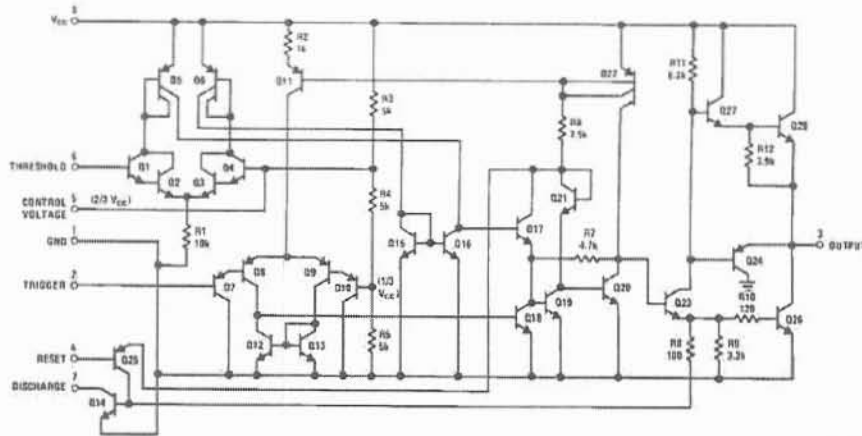
- Direct replacement for SE555/NE555
- Timing from microseconds through hours
- Operates in both astable and monostable modes

- Adjustable duty cycle
- Output can source or sink 200 mA
- Output and supply TTL compatible
- Temperature stability better than 0.005% per °C
- Normally on and normally off output

Applications

- Precision timing
- Pulse generation
- Sequential timing
- Time delay generation
- Pulse width modulation
- Pulse position modulation
- Linear ramp generator
- Available in 8 pin MSOP package

Schematic Diagram



LM555/LM555C Timer

555 Timer Manufacturer's Datasheet (continued)

Absolute Maximum Ratings (Note *NO TARGET FOR FNXref NS0071*)		LM555	-55°C to +125°C					
If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.		Storage Temperature Range	-65°C to +150°C					
Supply Voltage	+18V	Soldering Information						
Power Dissipation (Note 1)		Dual-In-Line Package						
LM555H, LM555CH	760 mW	Soldering (10 Seconds)	260°C					
LM555, LM555CN	1180 mW	Small Outline Package						
Operating Temperature Ranges		Vapor Phase (60 Seconds)	215°C					
LM555C	0°C to +70°C	Infrared (15 Seconds)	220°C					
		See AN-450 "Surface Mounting Methods and Their Effect on Product Reliability" for other methods of soldering surface mount devices.						
Electrical Characteristics								
(T _A = 25°C, V _{CC} = +5V to +15V, unless otherwise specified)								
Parameter	Conditions	Limits						Units
		LM555			LM555C			
		Min	Typ	Max	Min	Typ	Max	
Supply Voltage		4.5		18	4.5		16	V
Supply Current	V _{CC} = 5V, R _L = ∞		3	5		3	6	mA
	V _{CC} = 15V, R _L = ∞ (Low State) (Note 2)		10	12		10	15	mA
Timing Error, Monostable								
Initial Accuracy	R _A = 1k to 100 kΩ, C = 0.1 μF, (Note 3)		0.5			1		%
Drift with Temperature			30			50		ppm/°C
Accuracy over Temperature			1.5			1.5		%
Drift with Supply		0.05			0.1		%/V	
Timing Error, Astable								
Initial Accuracy	R _A , R _B = 1k to 100 kΩ, C = 0.1 μF, (Note 3)		1.5			2.25		%
Drift with Temperature			90			150		ppm/°C
Accuracy over Temperature			2.5			3.0		%
Drift with Supply		0.15			0.30		%/V	
Threshold Voltage				0.667			0.667	x V _{CC}
Trigger Voltage	V _{CC} = 15V	4.8	5	5.2		5		V
	V _{CC} = 5V	1.45	1.67	1.9		1.67		V
Trigger Current			0.01	0.5		0.5	0.9	μA
Reset Voltage		0.4	0.5	1	0.4	0.5	1	V
Reset Current			0.1	0.4		0.1	0.4	mA
Threshold Current	(Note 4)		0.1	0.25		0.1	0.25	μA
Control Voltage Level	V _{CC} = 15V	9.6	10	10.4	9	10	11	V
	V _{CC} = 5V	2.9	3.33	3.8	2.6	3.33	4	V
Pin 7 Leakage Output High			1	100		1	100	nA
Pin 7 Sat (Note 5)								
Output Low	V _{CC} = 15V, I ₇ = 15 mA		150			180		mV
Output Low	V _{CC} = 4.5V, I ₇ = 4.5 mA		70	100		80	200	mV

555 Timer Manufacturer's Datasheet (continued)

Electrical Characteristics (Continued)								
(T _A = 25°C, V _{CC} = +5V to +15V, unless otherwise specified)								
Parameter	Conditions	Limits						Units
		LM555			LM555C			
		Min	Typ	Max	Min	Typ	Max	
Output Voltage Drop (Low)	V _{CC} = 15V							
	I _{SINK} = 10 mA		0.1	0.15		0.1	0.25	V
	I _{SINK} = 50 mA		0.4	0.5		0.4	0.75	V
	I _{SINK} = 100 mA		2	2.2		2	2.5	V
	I _{SINK} = 200 mA		2.5			2.5		V
	V _{CC} = 5V							
Output Voltage Drop (High)	I _{SOURCE} = 200 mA, V _{CC} = 15V		12.5			12.5		V
	I _{SOURCE} = 100 mA, V _{CC} = 15V	13	13.3		12.75	13.3		V
	V _{CC} = 5V	3	3.3		2.75	3.3		V
Rise Time of Output			100			100		ns
Fall Time of Output			100			100		ns

Note 1: For operating at elevated temperatures the device must be derated above 25°C based on a +150°C maximum junction temperature and a thermal resistance of 154°C/W (TO-5), 106°C/W (DIP) and 170°C/W (SO-8) junction to ambient.

Note 2: Supply current when output high typically 1 mA less at V_{CC} = 5V.

Note 3: Tested at V_{CC} = 5V and V_{CC} = 15V.

Note 4: This will determine the maximum value of R_A + R_B for 15V operation. The maximum total (R_A + R_B) is 20 MΩ.

Note 5: No protection against excessive pin 7 current is necessary providing the package dissipation rating will not be exceeded.

Note 6: Refer to RET555X drawing of military LM555H and LM555J versions for specifications.

Connection Diagrams

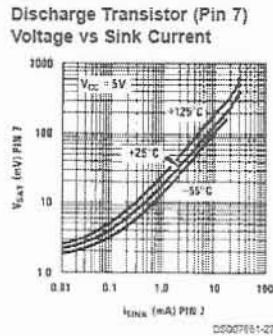
Metal Can Package

Top View
Order Number LM555H or LM555CH
See NS Package Number H08C

Dual-In-Line and Small Outline Packages

Top View
Order Number LM555J, LM555CJ,
LM555CM, LM555CN or LM555CMM
See NS Package Number J08A, M08A or N08E

Typical Performance Characteristics (Continued)



Applications Information

MONOSTABLE OPERATION

In this mode of operation, the timer functions as a one-shot (Figure 1). The external capacitor is initially held discharged by a transistor inside the timer. Upon application of a negative trigger pulse of less than $1/3 V_{CC}$ to pin 2, the flip-flop is set which both releases the short circuit across the capacitor and drives the output high.

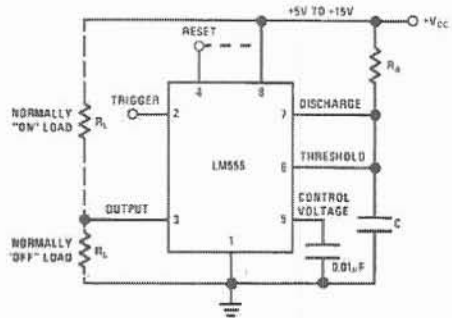
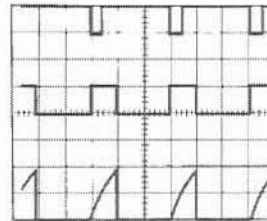


FIGURE 1. Monostable

The voltage across the capacitor then increases exponentially for a period of $t = 1.1 R_A C$, at the end of which time the voltage equals $2/3 V_{CC}$. The comparator then resets the flip-flop which in turn discharges the capacitor and drives the output to its low state. Figure 2 shows the waveforms generated in this mode of operation. Since the charge and the threshold level of the comparator are both directly proportional to supply voltage, the timing interval is independent of supply.



$V_{CC} = 5V$
 TIME = 0.1 ms/DIV.
 $R_A = 9.1 k\Omega$
 $C = 0.01 \mu F$

Top Trace: Input 5V/Div.
 Middle Trace: Output 5V/Div.
 Bottom Trace: Capacitor Voltage 2V/Div.

FIGURE 2. Monostable Waveforms

During the timing cycle when the output is high, the further application of a trigger pulse will not effect the circuit so long as the trigger input is returned high at least $10 \mu s$ before the end of the timing interval. However the circuit can be reset during this time by the application of a negative pulse to the reset terminal (pin 4). The output will then remain in the low state until a trigger pulse is again applied.

When the reset function is not in use, it is recommended that it be connected to V_{CC} to avoid any possibility of false triggering.

Figure 3 is a nomograph for easy determination of R, C values for various time delays.

NOTE: In monostable operation, the trigger should be driven high before the end of timing cycle.



March 1998

DM7490A, DM7493A Decade and Binary Counters

General Description

Each of these monolithic counters contains four master-slave flip-flops and additional gating to provide a divide-by-two counter and a three-stage binary counter for which the count cycle length is divide-by-five for the 90A and divide-by-eight for the 93A.

All of these counters have a gated zero reset and the 90A also has gated set-to-nine inputs for use in BCD nine's complement applications.

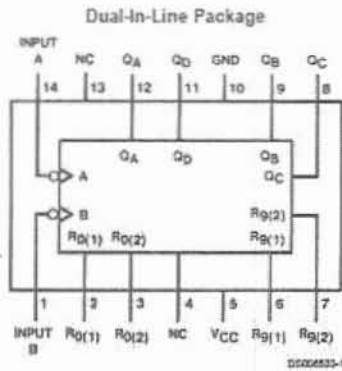
To use their maximum count length (decade or four-bit binary), the B input is connected to the Q_D output. The input count pulses are applied to input A and the outputs are as

described in the appropriate truth table. A symmetrical divide-by-ten count can be obtained from the 90A counters by connecting the Q_D output to the A input and applying the input count to the B input which gives a divide-by-ten square wave at output Q_A .

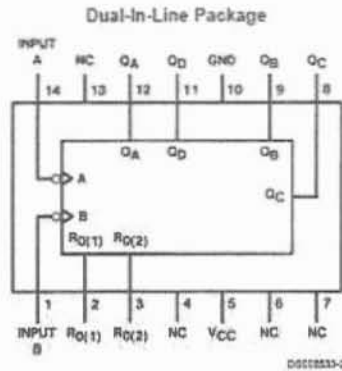
Features

- Typical power dissipation
 - 90A 145 mW
 - 93A 130 mW
- Count frequency 42 MHz

Connection Diagrams



Order Number DM5490J, DM5490W
or DM7490AN
See Package Number J14A, N14A or W14B



Order Number DM7493AN
See Package Number N14A

7490 Decade Counter Manufacturer's Datasheet (continued)

'93A Switching Characteristics (Continued)

at $V_{CC} = 5V$ and $T_A = 25^\circ C$

Symbol	Parameter	From (Input) To (Output)	$R_L = 400\Omega$ $C_L = 15 pF$		Units
			Min	Max	
t_{PHL}	Propagation Delay Time High to Low Level Output	B to Q_D		51	ns
t_{PHL}	Propagation Delay Time High to Low Level Output	SET-0 to Any Q		40	ns

Function Tables (Note 15)

**90A
BCD Count Sequence**

(Note 12)

Count	Outputs			
	Q_D	Q_C	Q_B	Q_A
0	L	L	L	L
1	L	L	L	H
2	L	L	H	L
3	L	L	H	H
4	L	H	L	L
5	L	H	L	H
6	L	H	H	L
7	L	H	H	H
8	H	L	L	L
9	H	L	L	H

**93A
Count Sequence**

(Note 14)

Count	Outputs			
	Q_D	Q_C	Q_B	Q_A
0	L	L	L	L
1	L	L	L	H
2	L	L	H	L
3	L	L	H	H
4	L	H	L	L
5	L	H	L	H
6	L	H	H	L
7	L	H	H	H
8	H	L	L	L
9	H	L	L	H
10	H	L	H	L
11	H	L	H	H
12	H	H	L	L
13	H	H	L	H
14	H	H	H	L
15	H	H	H	H

**90A
BCD Bi-Quinary (5-2)**

(Note 13)

Count	Outputs			
	Q_A	Q_D	Q_C	Q_B
0	L	L	L	L
1	L	L	L	H
2	L	L	H	L
3	L	L	H	H
4	L	H	L	L
5	H	L	L	L
6	H	L	L	H
7	H	L	H	L
8	H	L	H	H
9	H	H	L	L

Function Tables (Note 15) (Continued)

90A
Reset/Count Function Table

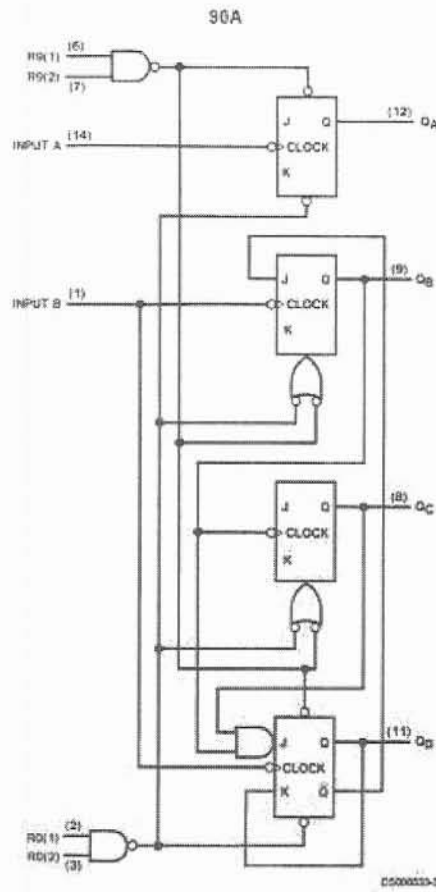
Reset Inputs				Outputs			
R0(1)	R0(2)	R9(1)	R9(2)	Q _D	Q _C	Q _B	Q _A
H	H	L	X	L	L	L	L
H	H	X	L	L	L	L	L
X	X	H	H	H	L	L	H
X	L	X	L	COUNT			
L	X	L	X	COUNT			
L	X	X	L	COUNT			
X	L	L	X	COUNT			

93A
Reset/Count Function Table

Reset Inputs		Outputs			
R0(1)	R0(2)	Q _D	Q _C	Q _B	Q _A
H	H	L	L	L	L
L	X	COUNT			
X	L	COUNT			

Note 12: Output Q_A is connected to input B for BCD count.
 Note 13: Output Q_D is connected to input A for bi-quinary count.
 Note 14: Output Q_A is connected to input B.
 Note 15: H = High Level, L = Low Level, X = Don't Care.

Logic Diagrams



The J and K inputs shown without connection are for reference only and are functionally at a high level.

BCD driver Manufacturer's Datasheet

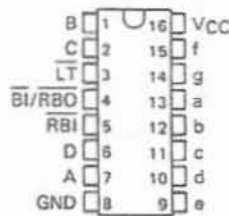
SN5446A, '47A, '48, SN54LS47, 'LS48, 'LS49 SN7446A, '47A, '48, SN74LS47, 'LS48, 'LS49 BCD-TO-SEVEN-SEGMENT DECODERS/DRIVERS

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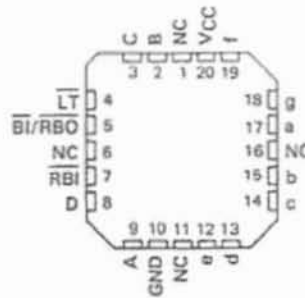
'46A, '47A, 'LS47 feature	'48, 'LS48 feature	'LS49 feature
<ul style="list-style-type: none"> • Open-Collector Outputs Drive Indicators Directly • Lamp-Test Provision • Leading/Trailing Zero Suppression 	<ul style="list-style-type: none"> • Internal Pull-Ups Eliminate Need for External Resistors • Lamp-Test Provision • Leading/Trailing Zero Suppression 	<ul style="list-style-type: none"> • Open-Collector Outputs • Blanking Input

SN5446A, SN5447A, SN54LS47, SN5448,
SN54LS48 . . . J PACKAGE
SN7446A, SN7447A,
SN7448 . . . N PACKAGE
SN74LS47, SN74LS48 . . . D OR N PACKAGE

(TOP VIEW)

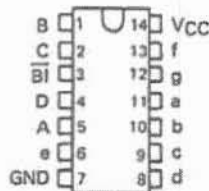


SN54LS47, SN54LS48 . . . FK PACKAGE
(TOP VIEW)

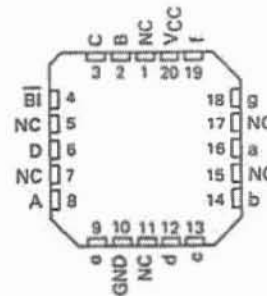


SN54LS49 . . . J OR W PACKAGE
SN74LS49 . . . D OR N PACKAGE

(TOP VIEW)



SN54LS49 . . . FK PACKAGE
(TOP VIEW)



NC - No internal connection

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

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BCD driver Manufacturer's Datasheet (continued)

SN5446A, '47A, '48, SN54LS47, 'LS48, 'LS49
 SN7446A, '47A, '48, SN74LS47, 'LS48, 'LS49
 BCD-TO-SEVEN-SEGMENT DECODERS/DRIVERS
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description

The '46A, '47A, and 'LS47 feature active-low outputs designed for driving common-anode LEDs or incandescent indicators directly. The '48, 'LS48, and 'LS49 feature active-high outputs for driving lamp buffers or common-cathode LEDs. All of the circuits except 'LS49 have full ripple-blanking input/output controls and a lamp test input. The 'LS49 circuit incorporates a direct blanking input. Segment identification and resultant displays are shown below. Display patterns for BCD input counts above 9 are unique symbols to authenticate input conditions.

The '46A, '47A, '48, 'LS47, and 'LS48 circuits incorporate automatic leading and/or trailing-edge zero-blanking control (RBI and RBO). Lamp test (LT) of these types may be performed at any time when the BI/RBO node is at a high level. All types (including the '49 and 'LS49) contain an overriding blanking input ($\overline{\text{BI}}$), which can be used to control the lamp intensity by pulsing or to inhibit the outputs. Inputs and outputs are entirely compatible for use with TTL logic outputs.

The SN54246/SN74246 and '247 and the SN54LS247/SN74LS247 and 'LS248 compose the $\overline{\text{B}}$ and the $\overline{\text{S}}$ with tails and were designed to offer the designer a choice between two indicator fonts.



'46A, '47A, 'LS47 FUNCTION TABLE (T1)

DECIMAL OR FUNCTION	INPUTS						$\overline{\text{BI/RBO}}^1$	OUTPUTS							NOTE
	LT	RBI	D	C	B	A		a	b	c	d	e	f	g	
0	H	H	L	L	L	L	H	ON	ON	ON	ON	ON	ON	OFF	
1	H	X	L	L	L	H	H	OFF	ON	ON	OFF	OFF	OFF	OFF	
2	H	X	L	L	H	L	H	ON	ON	OFF	ON	ON	OFF	ON	
3	H	X	L	L	H	H	H	ON	ON	ON	ON	OFF	OFF	ON	
4	H	X	L	H	L	L	H	OFF	ON	ON	OFF	OFF	ON	ON	
5	H	X	L	H	L	H	H	ON	OFF	ON	ON	OFF	ON	ON	
6	H	X	L	H	H	L	H	OFF	OFF	ON	ON	ON	ON	ON	
7	H	X	L	H	H	H	H	ON	ON	ON	OFF	OFF	OFF	OFF	1
8	H	X	H	L	L	L	H	ON	ON	ON	ON	ON	ON	ON	
9	H	X	H	L	L	H	H	ON	ON	ON	OFF	OFF	ON	ON	
10	H	X	H	L	H	L	H	OFF	OFF	OFF	ON	ON	OFF	ON	
11	H	X	H	L	H	H	H	OFF	OFF	ON	ON	OFF	OFF	ON	
12	H	X	H	H	L	L	H	OFF	ON	OFF	OFF	OFF	ON	ON	
13	H	X	H	H	L	H	H	ON	OFF	OFF	ON	OFF	ON	ON	
14	H	X	H	H	H	L	H	OFF	OFF	OFF	ON	ON	ON	ON	
15	H	X	H	H	H	H	H	OFF	OFF	OFF	OFF	OFF	OFF	OFF	
BI	X	X	X	X	X	X	L	OFF	OFF	OFF	OFF	OFF	OFF	OFF	2
RBI	H	L	L	L	L	L	L	OFF	OFF	OFF	OFF	OFF	OFF	OFF	3
LT	L	X	X	X	X	X	H	ON	ON	ON	ON	ON	ON	ON	4

H = high level, L = low level, X = irrelevant

- NOTES:
- The blanking input ($\overline{\text{BI}}$) must be open or held at a high logic level when output functions 0 through 15 are desired. The ripple-blanking input ($\overline{\text{RBI}}$) must be open or high if blanking of a decimal zero is not desired.
 - When a low logic level is applied directly to the blanking input ($\overline{\text{BI}}$), all segment outputs are off regardless of the level of any other input.
 - When ripple-blanking input ($\overline{\text{RBI}}$) and inputs A, B, C, and D are at a low level with the lamp test input high, all segment outputs go off and the ripple-blanking output ($\overline{\text{RBO}}$) goes to a low level (response condition).
 - When the blanking input/ripple blanking output ($\overline{\text{BI/RBO}}$) is open or held high and a low is applied to the lamp-test input, all segment outputs are on.

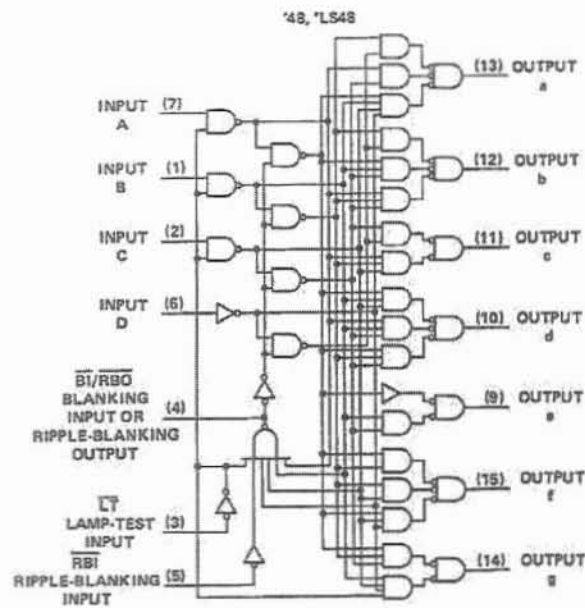
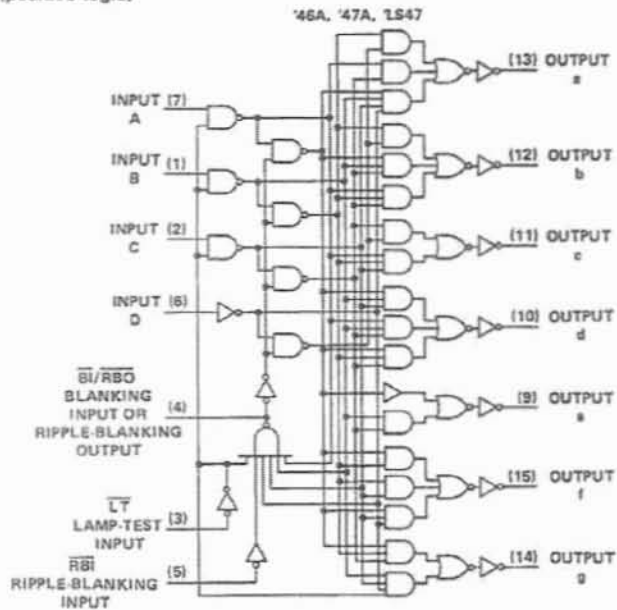
¹ BI/RBO is wire AND logic serving as blanking input ($\overline{\text{BI}}$) and/or ripple-blanking output ($\overline{\text{RBO}}$).

BCD driver Manufacturer's Datasheet (continued)

SN5446A, '47A, '48, SN54LS47, 'LS48, 'LS49
 SN7446A, '47A, '48, SN74LS47, 'LS48, 'LS49
 BCD-TO-SEVEN-SEGMENT DECODERS/DRIVERS

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logic diagrams (positive logic)



Pin numbers shown are for D, J, N, and W packages.

Appendix A5 – Lab Instructions

One Minute Digital Clock

This experiment will acquaint you with some of the basics of electronic circuitry. In this experiment you will build a two digit electronic clock using the material list below. By following this step-by-step procedure you should be able to assemble a functioning digital clock that counts from 00 to 59.

Introduction

Our clock consists of three building blocks. They are listed as follow:

- 1) 555 Timer Circuit
- 2) BCD Binary Counter
- 3) 7 segment display and BCD display driver

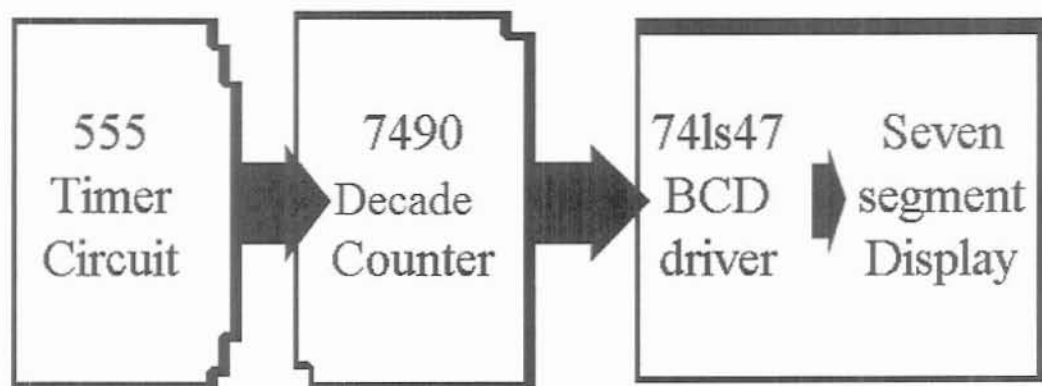


Fig A5.1: The 3 building blocks of the project

Overview of each building block

555 Timer Circuit

For any kind of timing device, there is something creating a cycle to measure the passage of time. For example Wind-up clocks uses oscillating wheels, and a grandfather clock uses a pendulum to measure time. For our clock, we will use the 555 Timer Circuit as a timing mechanism to create an electric pulse every second.

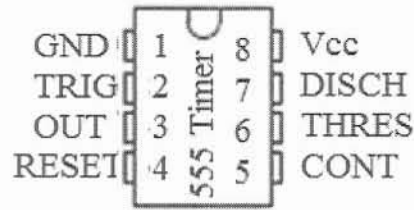


Fig A5.2: Overview 555 Timer

Decade counter 7490

Normally, this 7490 IC is able to count from 0 to 9 cyclically. As we can see in figure A5.3, the 7490 has 14 pins. There are four outputs: QA, QB, QC and QD which are 4 bits in a binary number. These pins cycle through 0 to 9.

Table A5.1: Output of decade counter 7490

QD	QC	QB	QA	Decimal
0	0	0	0	0
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
0	1	1	0	6
0	1	1	1	7
1	0	0	0	8
1	0	0	1	9

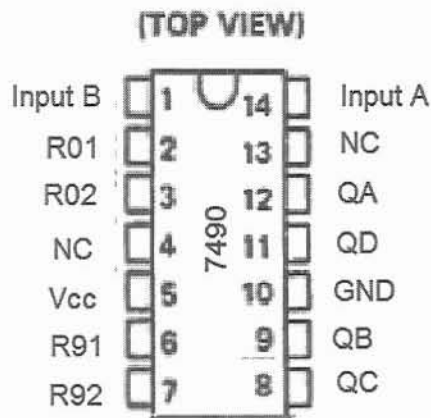


Fig A5.3: Overview decade counter 7490

BCD-to-seven-segment display driver 74LS47

The 74LS47 BCD driver takes the four outputs of the 7490 decade counter, and converts them into 7 outputs. You can think of the display as having 7 light bulbs and each light bulb has one control.

Table A5.2: This table shows different combinations of inputs of the 74ls47 and its corresponding output

Numbering System			Output controlling the Seven Segments						
Binary	BCD	Decimal	OA	OB	OC	OD	OE	OF	OG
0	0000	0	1	1	1	1	1	1	0
1	0001	1	0	1	1	0	0	0	0
10	0010	2	1	1	0	1	1	0	1
11	0011	3	1	1	1	1	0	0	1
100	0100	4	0	1	1	0	0	1	1
101	0101	5	1	0	1	1	1	0	1
110	0110	6	0	0	1	1	1	1	1
111	0111	7	1	1	1	0	0	0	0
1000	1000	8	1	1	1	1	1	1	1
1001	1001	9	1	1	1	0	0	1	1

In the table, the column BCD refers to the inputs the 74LS47 driver receives, 0001 means inputs B,C, D are 0 and input A is 1 since A is the least significant bit. The column OA to OG refers to the output that we get from the 74LS47. So, 0001 will make segment b and segment c (fig A5.5) light up, which gives a digit '1' on the display.

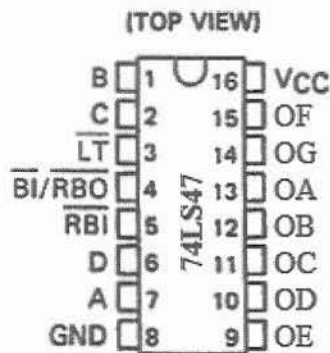


Fig A5.4: Overview 74LS47 BCD driver

7 segment Display and

The seven segment displays are the digits that you will see to be lit up once you have correctly constructed your digital clock. The 7 segment display can take 7 inputs and each of these inputs controls a segment of a number. By controlling which segments turn on and which ones turn off, it is possible to display the

numbers 0-9 on one display. However, the decade counter 7490 only produces 4 outputs and we need to have 7 inputs. To get the last three inputs we need to add a driver/decoder 74LS47 to convert 4 inputs into 7.

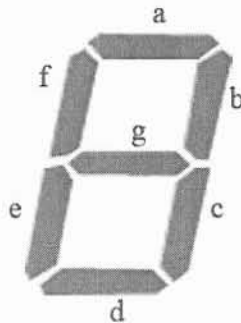


Fig A5.5: Seven Segment Display
Each letter represents one segment

Putting them together

Because of the setting of class, the lab will be broken down into 3 parts. You will first start building the timer which you will test by using an oscilloscope. After completing the timer, you will build the first digit which will count from 0 to 9. Then, you will build the last digit which will count from 0 to 5. Finally, you will assemble them together to create a 'One minute digital clock'.

Material List

Table A5.3: Material list

Quantity	Item
1	555Timer IC
2	Decade Counter 7490 IC
2	BCD Driver 74LS47 IC
2	Common Anode 7-segment Display
2	Network resistor 390 ohm
1	Potentiometer
2	Resistor 2k Ω
1	Capacitor 100 μ F
1	Breadboard with 5volt Power Supply
50	Wires (each around 2 inch long)
1	Multi-meter
1	Oscilloscope

Part One – Building the 555 Timer Circuit

In the beginning part of the lab you will be constructing a 555 timer circuit. You will use the schematic below to help you build the circuit.

Caution: Turn off the power supply before making connections. Make sure to pay attention to the polarity on the capacitor. The negative terminal (shorter) should go to ground

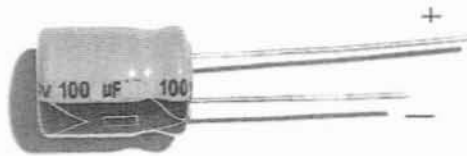


Fig A5.6: Capacitor polarity

The goal you should achieve when building this circuit is to create an electric pulse every second. This means you will want to have an output frequency of approximately 1 Hz. To change the frequency of the timer there is a potentiometer in the circuit. By adjusting the small knob on the potentiometer the frequency can be adjusted as well.

After building the circuit, use the oscilloscope to check the output at pin 3. What you should see is a square wave. Obtain 1Hz frequency by adjusting the potentiometer.

Use the formula below to obtain the resistance value of the potentiometer which is R3 in the schematic.

$$f = \frac{1}{0.693 \cdot C \cdot [R1 + 2(R2 + R3)]}$$

C: Capacitance

f: 1Hz

R1, R2: 2k Ω

Measure the actual resistance of the potentiometer. Compare the measured value and the theoretical value.

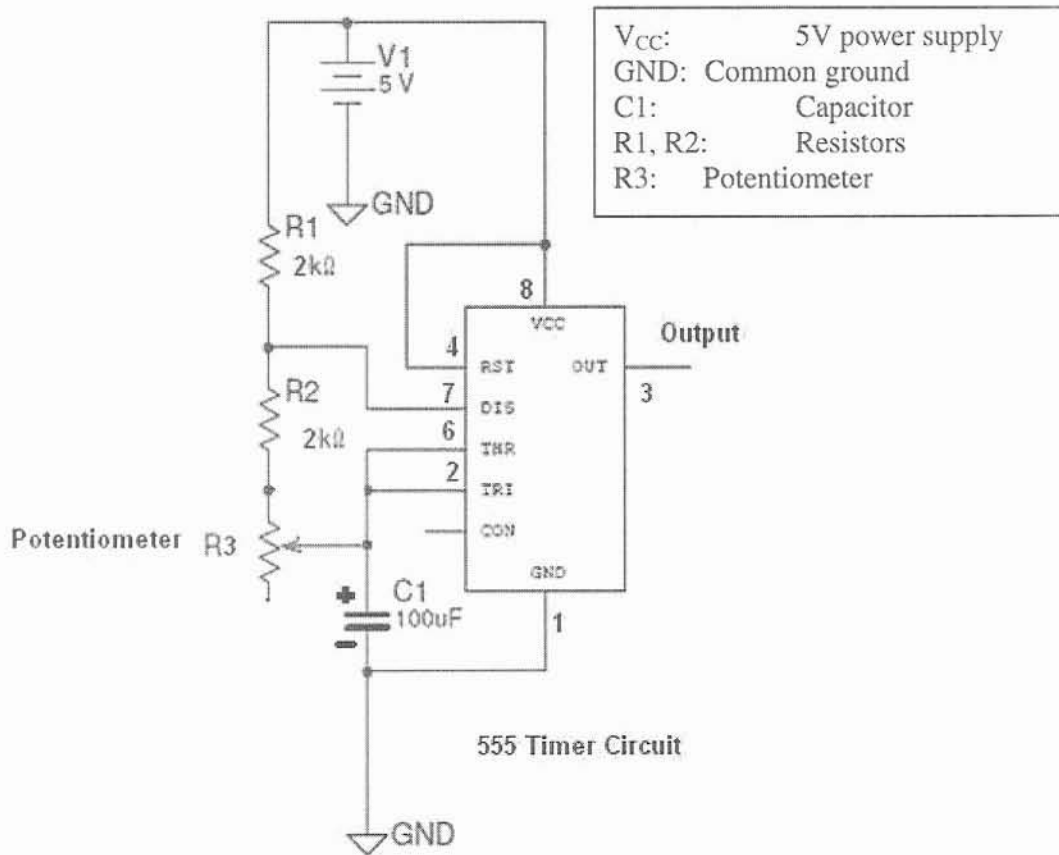


Fig A5.7: Schematic of Timer Circuit

Part Two – Building the first digit (0 to 9)

This counter is going to count from 0 to 9. The counter consists of three main components: the decade counter 7490, the BCD-to-seven-segment driver 74LS47, and the common anode seven-segment display.

Caution: Turn off the power supply before making connections.

1. Connections of 7490 Decade counter

Table A5.4: Connections of the 7490 IC

7490 Pin Name*	7490 Pin*	7490 Connection**	74LS47 Connection***
Input B	1	12	
RO1	2		
RO2	3		
NC	4		
Vcc	5	Vcc = 5 Volts	
R91	6		
R92	7		
QC	8		2
QB	9		1
GND	10	GND = 0 Volts	
QD	11		6
QA	12	1	7
NC	13		
Input A	14	Clock signal from 555	

Note

*The first and the second column show the name and the pin number respectively.

**The third column indicates the connections which have to be made within the 7490, i.e. pin 1 should be connected to pin 12 within the 7490.

***The fourth column indicates the connections between the 7490 (second column) and the 74LS47, i.e. pin 8 of the 7490 should be wired to pin 2 of the 74LS47.

2. Connections of 74LS47 BCD driver

Table A5.5: Connections of the 74LS47 BCD driver

74LS47 Pin Name*	74LS47 Pin*	7-Segment Display Connection**	Other***
Input B	1		
Input C	2		
LT	3		5 Volts
BI/RBO	4		5 Volts
RBI	5		5 Volts
Input D	6		
Input A	7		
GND	8		Common ground
e	9	1	
d	10	2	
c	11	4	
b	12	6	
a	13	7	
g	14	10	
f	15	9	
Vcc	16		5 Volts

Note

Please refer to fig A5.8 for schematic.

*The first and the second column show the name and the pin number respectively.

**The third column indicates the connections between the 74LS47 and the 7-segment display.

***The fourth column indicates the connections from the 74LS47 to either 5V power supply or common ground.

3. The connection of 7-segment-display

Follow the table A5.5.

Note:

Pin 3 and 8 must be connected to 5 Volts power supply.

Part Three – Building the tenth digit (0 to 5)

This counter is going to count from 0 to 5 (decimal value). The counter will be constructed in a similar fashion to the 0-9 counter which we have built in the previous section. However, there are some connections which should be adjusted so that the counter counts from 0 to 5 instead of 9.

Caution: Turn off the power supply before making connections.

The adjustment is made on the decade counter 7490 as follows:

Table A5.6: Connections of the 7490 IC

7490 Pin Name*	7490 Pin*	7490 Connection**	74LS47 Connection***
Input B	1	12	
RO1	2	9	
RO2	3	8	
NC	4		
Vcc	5	Vcc = 5 Volts	
R91	6		
R92	7		
QC	8		2
QB	9		1
GND	10	GND = 0 Volts	
QD	11		
QA	12	1	7
NC	13		
Input A	14	Clock signal from 555	

Note

Please refer to fig A5.9 for schematic.

*The first and the second column show the name and the pin number respectively.

**The third column indicates the connections which have to be made within the 7490, i.e. pin 1 should be connected to pin 12 within the 7490.

***The fourth column indicates the connections between the 7490 (second column) and the 74LS47, i.e. pin 8 of the 7490 should be wired to pin 2 of the 74LS47.

Part Four – Finishing the digital clock

Up to this point, you have constructed successfully a timer circuit which creates an electric pulse every second, a counter counting from 0 to 9, and another counter counting from 0 to 5. In this final part of the lab, we are going to put these circuits together in order to build our ‘One minute digital clock.’

The clock is going to count from 0 to 59 every second. Then it will reset to 0 and continue counting. Therefore, the first counter which we have built in part two should count from 0 to 9 every second; while the second counter in part three should count from 0 to 5 every ten seconds. In other words, when the first counter counts up to 9 and resets to 0, the second counter will be increased by 1. To achieve this goal, you must follow the steps below (Please refer to the fig A5.10):

- Step 1: Turn off the power supply if it is on.
- Step 2: Disconnect the clock signal from the timer circuit to the input A (pin 14) of the 7490 in the second counter.
- Step 3: Connect the clock signal back to the input A (pin 14) of the 7490 in the first counter.
- Step 4: Use a wire to connect the output QD (pin 11) of the 7490 in the first counter to the input A (pin 14) of the 7490 in the second counter.
- Step 5: Turn on the power supply and YES! YOU HAVE BUILT YOUR OWN DIGITAL CLOCK. ENJOY IT!

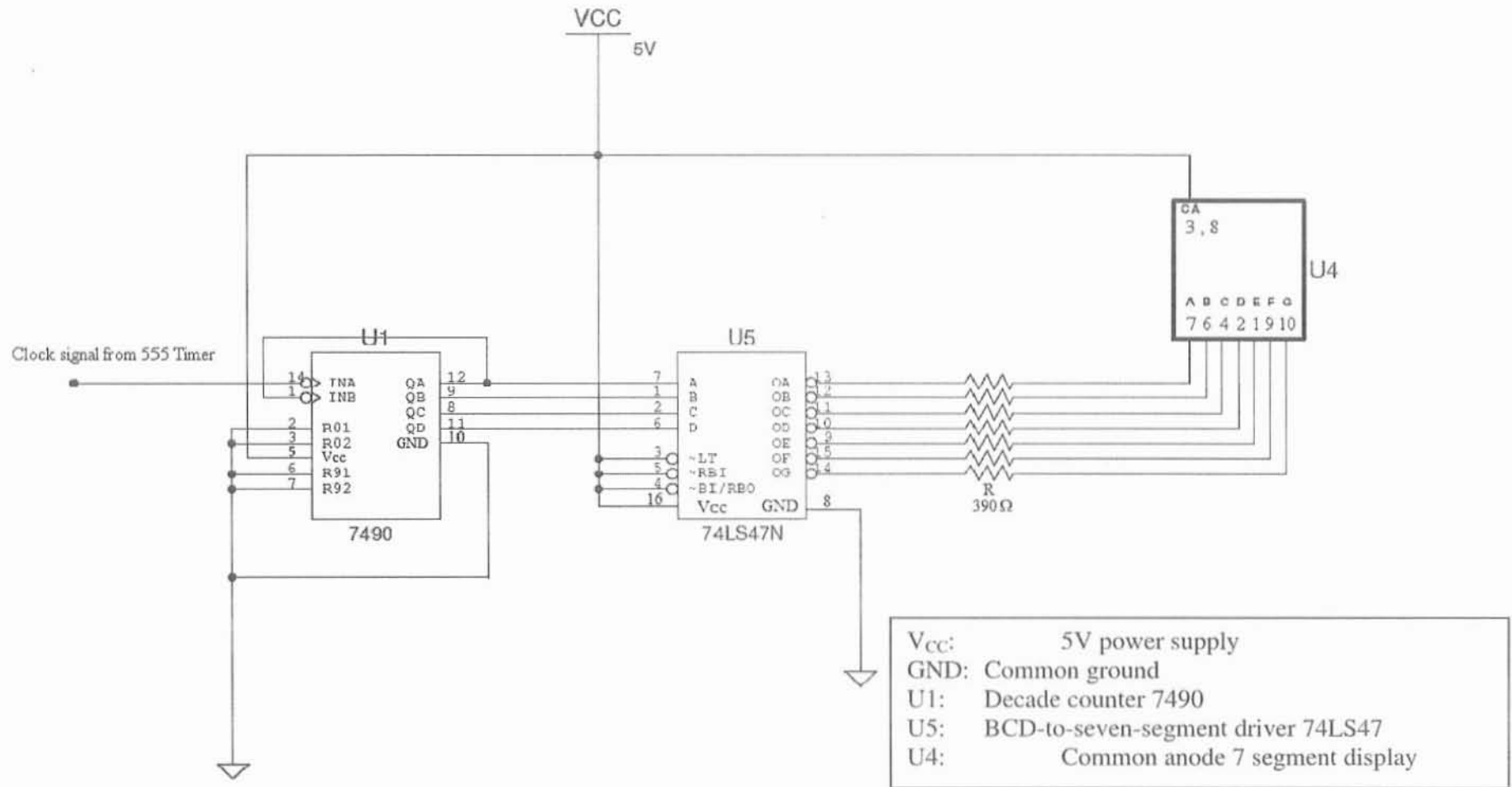


Fig A5.8: Schematic of 0 to 9 digit circuit

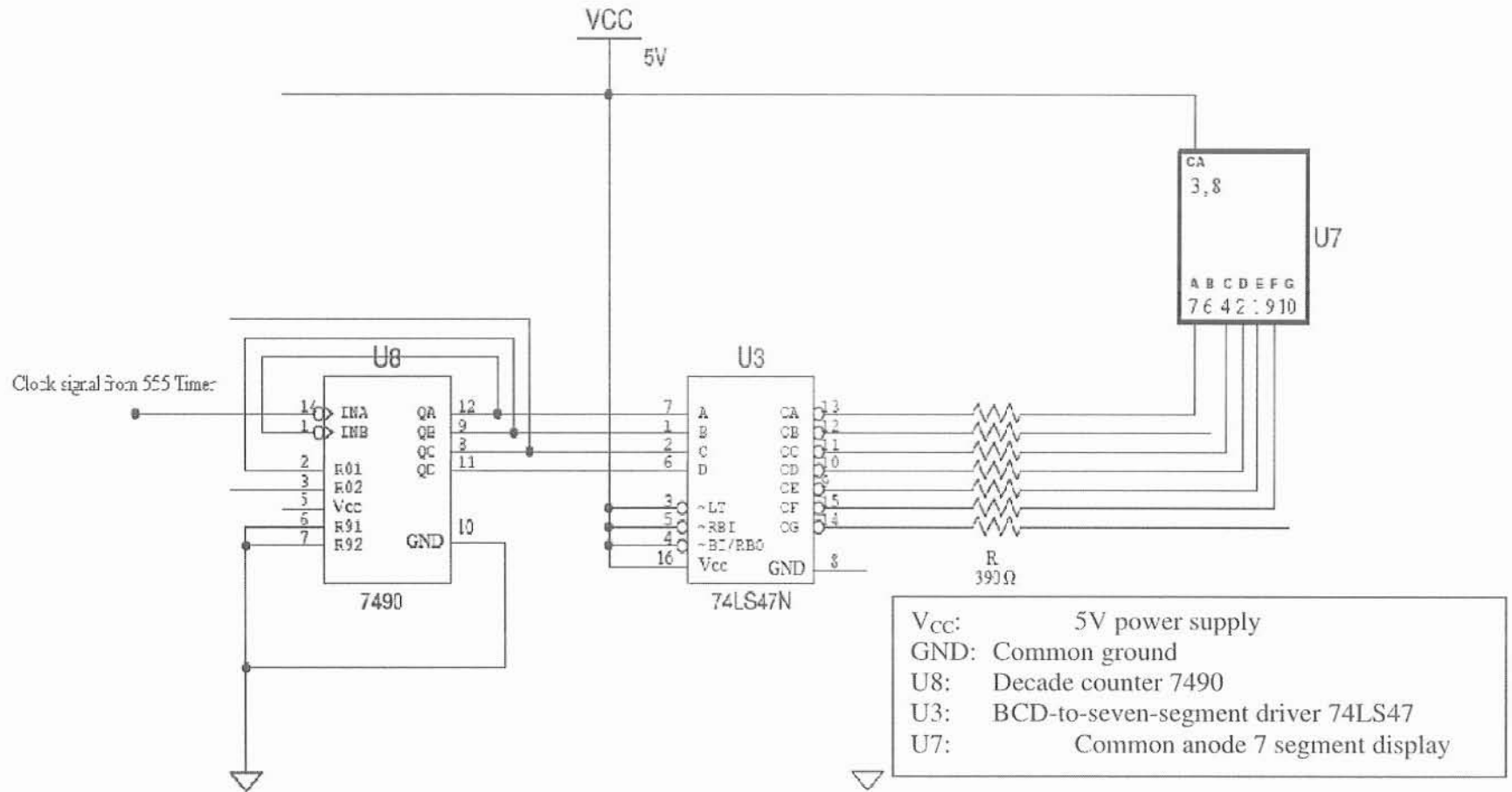


Fig A5.9: Schematic of 0 to 5 digit circuit

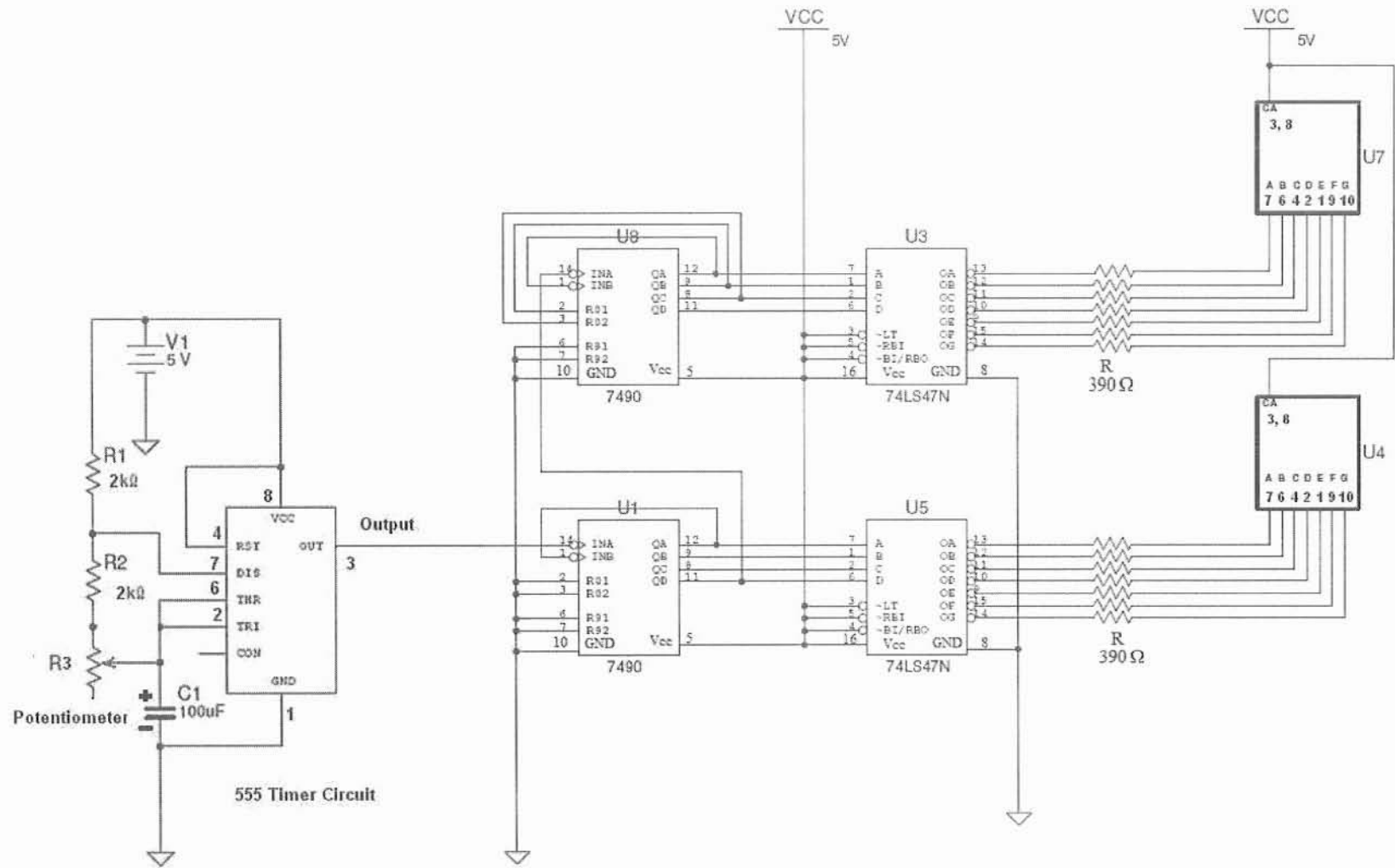


Fig A5.10: One Minute Digital Clock

Appendix A6 – Materials List

Quantity	Item
1	555Timer IC
2	Decade Counter 7490 IC
2	BCD Driver 74LS47 IC
2	Common Anode 7-segment Display
2	Network resistor 390 ohm
1	Potentiometer
2	Resistor 2k Ω
1	Capacitor 100 μ F
1	Breadboard with 5volt Power Supply
50	Wires (each around 2 inch long)
1	Multi-meter
1	Oscilloscope

Appendix A7 – Pre-test

Pre-Test

Name : _____
Date : _____
Class year: _____

One Minute Digital Clock

Pre-test

Please circle the correct answer.

1. The 555-Timer IC is:

- A. a digital circuit which is able to produce square waves.
- B. an electronic circuit which can be used as a digital watch.
- C. an integrated circuit which can produce oscillation.
- D. a counter which can count from 0 to 9 (decimal value).

2. What is the value of resistance R2 in the following equation?

$$T = 0.693 \cdot C(R1 + 2 \cdot R2)$$

$$T = 1s$$

$$C = 100\mu F$$

$$R1 = 2k\Omega$$

3. JK Flip-Flop is:

- A. a logic gate which is able to produce output 0 (low) or 1 (high).
- B. a digital circuit which consists of an inverter and NAND gates.
- C. an analog circuit which consists of a diode and some transistors.
- D. a digital circuit which functions as a digital switch.

4. True or False

- A. JK Flip-Flops operate normally without the clock signal.

T F

B. The state (0 or 1) of the output Q of a JK Flip-Flop is determined by the previous state of Q, the input J, and the input K.

T F

C. A Transistor-Transistor Logic Integrated Circuit (TTL IC) can have an odd number of pins.

T F

D. A Transistor-Transistor Logic Integrated Circuit (TTL IC) will not operate without being connected to a voltage supply.

T F

5. What does BCD stand for?

- A. Binary-Called Decimal
- B. Binary-Coded Decimal
- C. Binary-Converted Decimal
- D. Binary-Changed Decimal

6. Which number is in BCD form?

- A. 0101
- B. 1010
- C. Both of them.
- D. None of them.

7. How many inputs does a 74LS47 IC (BCD-to-seven-segment driver) take?

- A. 2
- B. 3
- C. 4
- D. 7

8. How many outputs does a 74LS47 IC (BCD-to-seven-segment driver) produce?

- A. 2
- B. 3
- C. 4
- D. 7

Pre-test Answers

1. C

2. $R_2 = 6215\Omega \approx 6.2 \text{ k}\Omega$

3. B

4.

A. F

B. T

C. F

D. T

5. B

6. A

7. C

8. D

Appendix A8 – Post-test

Post-test

Name: _____

Date : _____

Class year: _____

One Minute Digital Clock

Post-test

Please circle the correct answer.

1. The 555-Timer IC can:

- E. perform counting mechanism.
- F. operate as a clock.
- G. take 4 inputs and produce 7 outputs.
- H. produce a square wave at the output pin.

2. What is the value of the capacitance C in the following equation?

$$f = \frac{1}{0.693 \cdot C(R1 + 2 \cdot R2)}$$

$$f = 1\text{Hz}$$

$$R1 = 7.5\text{k}\Omega$$

$$R2 = 3.0\text{k}\Omega$$

3. Decade counter 7490 IC:

- A. contains 4 JK flip-flops and some logic gates.
- B. is able to count from 0 – 4 cyclically.
- C. Both of them.
- D. None of them.

4. True or False

- E. The 555 timer circuit provides a clock signal to the decade counter 7490.

T F

- F. The output Q of a JK flip-flop does not depend on two inputs J and K.

T F

- G. All Transistor-transistor logic integrated circuits have the same number of pins.

T F

H. The 74LS47 BCD driver takes 7 inputs and produces 4 outputs.

T F

5. The total pins of a 7-segment display are:

- A. 4
- B. 7
- C. 8
- D. 10

6. Convert 8 (decimal value) to BCD form:

7. What are the LSB - least significant bit and the MSB – most significant bit in the binary number 0101:

- A. LSB: 0 , MSB: 0
- B. LSB: 0 , MSB: 1
- C. LSB: 1 , MSB: 0
- D. LSB: 1 , MSB: 1

8. The 74LS47 BCD-to-seven-segment display driver:

- A. is able to count from 0 to 9 cyclically.
- B. is able to drive the seven segment displays.
- C. is able to take several inputs and produces an output.
- D. None of them.

Post-test Answers

1. D

2. $1.069E-4$ (F) \approx 100 (μ F)

3. C

4.

- A. T
- B. F
- C. F
- D. F

5. D

6. 1000

7. C

8. B

Appendix A9 – Evaluation

One Minute Digital Clock Activity Evaluation					
Statement	Strongly Disagree	Disagree	Agree	Strongly Agree	Comments
This overall activity has a high education value.					
This activity improves your skills of assembling electronic circuits.					
This activity improves your understanding about how to apply electronic principles in digital circuits.					
This activity improves your understanding about the differences between analog and digital devices.					
The lab instruction is easy to follow.					
The lab instruction covers everything that you need to know to accomplish the task.					
This activity improves your understanding about different digital devices. (i.e. 555 Timer, 7490 Decade counter, 7 segment Display and driver.)					
What did you most like about this activity?					
What did you least like about this activity?					
Is there anything else you would like the activity to have covered?					
Further Comments					

If you run out of space, please write on the back of this form.

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Name: _____
Date : _____
Class year: _____ 2007

One Minute Digital Clock
Prelab

Please circle the correct answer.

1. The 555-Timer IC is:

- A. a digital circuit which is able to produce square waves.
- B. an electronic circuit which can be used as a digital watch.
- C. an integrated circuit which can produce oscillation.
- D. a counter which can count from 0 to 9 (decimal value).

2. What is the value of resistance R2 in the following equation?

$$T = 0.693 \cdot C(R1 + 2 \cdot R2)$$

T = 1s
C = 100 μ F
R1 = 2k

6215 Ω

3. JK Flip-Flop is:

- A. a logic gate which is able to produce output 0 (low) or 1 (high).
- B. a digital circuit which consists of an inverter and NAND gates.
- C. an analog circuit which consists of a diode and some transistors.
- D. a digital circuit which functions as a digital switch.

4. True or False

- A. JK Flip-Flops operate normally without the clock signal. T F
- B. The state (0 or 1) of the output Q of a JK Flip-Flop is determined by the previous state of Q, the input J, and the input K. T F
- C. A Transistor-Transistor Logic Integrated Circuit (TTL IC) can have an odd number of pins. T F
- D. A Transistor-Transistor Logic Integrated Circuit (TTL IC) will not operate without being connected to a voltage supply. T F

5. What does BCD stand for?

- A. Binary-Called Decimal
- B. Binary-Coded Decimal
- C. Binary-Converted Decimal
- D. Binary-Changed Decimal

6. Which number is in BCD form?

- A. 0101
- B. 1010
- C. Both of them.
- D. None of them.

7. How many inputs does a 74LS47 IC (BCD-to-seven-segment driver) take?

- A. 2
- B. 3
- C. 4
- D. 7

8. How many outputs does a 74LS47 IC (BCD-to-seven-segment driver) produce?

- A. 2
- B. 3
- C. 4
- D. 7

Name: _____
Date : 10-20-06
Class year: 07

One Minute Digital Clock
Prelab

Please circle the correct answer.

1. The 555-Timer IC is:

- A. a digital circuit which is able to produce square waves.
- B. an electronic circuit which can be used as a digital watch.
- C. an integrated circuit which can produce oscillation.
- D. a counter which can count from 0 to 9 (decimal value).

2. What is the value of resistance R2 in the following equation?

$$R_2 = 100k \cdot 100 \mu F \cdot 1s / 2 \cdot 10^{-3}$$

$$T = 0.693 \cdot C(R1 + 2 \cdot R2)$$

T = 1s
C = 100μF
R1 = 2k

$$1s = 0.693 (10^{-3}) (2k + 2 \cdot R_2)$$

3. JK Flip-Flop is:

- A. a logic gate which is able to produce output 0 (low) or 1 (high).
- B. a digital circuit which consists of an inverter and NAND gates.
- C. an analog circuit which consists of a diode and some transistors.
- D. a digital circuit which functions as a digital switch.

4. True or False

- A. JK Flip-Flops operate normally without the clock signal. T F
- B. The state (0 or 1) of the output Q of a JK Flip-Flop is determined by the previous state of Q, the input J, and the input K. T F
- C. A Transistor-Transistor Logic Integrated Circuit (TTL IC) can have an odd number of pins. T F
- D. A Transistor-Transistor Logic Integrated Circuit (TTL IC) will not operate without being connected to a voltage supply. T F

5. What does BCD stand for?

- A. Binary-Called Decimal
- B. Binary-Coded Decimal
- C. Binary-Converted Decimal
- D. Binary-Changed Decimal

6. Which number is in BCD form?

- A. 0101
- B. 1010
- C. Both of them.
- D. None of them.

7. How many inputs does a 74LS47 IC (BCD-to-seven-segment driver) take?

- A. 2
- B. 3
- C. 4
- D. 7

8. How many outputs does a 74LS47 IC (BCD-to-seven-segment driver) produce?

- A. 2
- B. 3
- C. 4
- D. 7

Name: _____
Date : _____
Class year: 2022

One Minute Digital Clock Prelab

Please circle the correct answer.

1. The 555-Timer IC is:

- A. a digital circuit which is able to produce square waves.
- B. an electronic circuit which can be used as a digital watch.
- C. an integrated circuit which can produce oscillation.
- D. a counter which can count from 0 to 9 (decimal value).

2. What is the value of resistance R2 in the following equation?

$T = 0.693 \cdot C(R1 + 2 \cdot R2)$

$T = 1s$
 $C = 100\mu F$
 $R1 = 2k$

10403
 $1s \rightarrow 2000$
 $7214k = R2$

3. JK Flip-Flop is:

- A. a logic gate which is able to produce output 0 (low) or 1 (high).
- B. a digital circuit which consists of an inverter and NAND gates.
- C. an analog circuit which consists of a diode and some transistors.
- D. a digital circuit which functions as a digital switch.

4. True or False

- A. JK Flip-Flops operate normally without the clock signal. T F
- B. The state (0 or 1) of the output Q of a JK Flip-Flop is determined by the previous state of Q, the input J, and the input K. T F
- C. A Transistor-Transistor Logic Integrated Circuit (TTL IC) can have an odd number of pins. T F
- D. A Transistor-Transistor Logic Integrated Circuit (TTL IC) will not operate without being connected to a voltage supply. T F

5. What does BCD stand for?

- A. Binary-Called Decimal
- B. Binary-Coded Decimal
- C. Binary-Converted Decimal
- D. Binary-Changed Decimal

6. Which number is in BCD form?

- A. 0101
- B. 1010
- C. Both of them.
- D. None of them.

7. How many inputs does a 74LS47 IC (BCD-to-seven-segment driver) take?

- A. 2
- B. 3
- C. 4
- D. 7

8. How many outputs does a 74LS47 IC (BCD-to-seven-segment driver) produce?

- A. 2
- B. 3
- C. 4
- D. 7

Name: _____
Date : 10/24/06
Class year: Senior (12) 2007

One Minute Digital Clock
Prelab

Please circle the correct answer.

1. The 555-Timer IC is:

- A. a digital circuit which is able to produce square waves.
- B. an electronic circuit which can be used as a digital watch.
- C. an integrated circuit which can produce oscillation.
- D. a counter which can count from 0 to 9 (decimal value).

2. What is the value of resistance R2 in the following equation?

$$T = 0.693 \cdot C(R1 + 2 \cdot R2)$$

$$T = 1s$$
$$C = 100\mu F$$
$$R1 = 2k$$

$$1 = 0.693 \cdot (100\mu F (2000 + 2(R2)))$$
$$\frac{1}{0.693} = \frac{100 (2000 + 2(R2))}{100 \times 10^{-6}}$$

$$14000 = 2000 + 2(R2)$$
$$-2000 \quad -2000$$

$$12000 = 2(R2)$$
$$6000 = 6k = R2$$

3. JK Flip-Flop is:

- A. a logic gate which is able to produce output 0 (low) or 1 (high).
- B. a digital circuit which consists of an inverter and NAND gates.
- C. an analog circuit which consists of a diode and some transistors.
- D. a digital circuit which functions as a digital switch.

4. True or False

- A. JK Flip-Flops operate normally without the clock signal. T F
- B. The state (0 or 1) of the output Q of a JK Flip-Flop is determined by the previous state of Q, the input J, and the input K. T F
- C. A Transistor-Transistor Logic Integrated Circuit (TTL IC) can have an odd number of pins. T F
- D. A Transistor-Transistor Logic Integrated Circuit (TTL IC) will not operate without being connected to a voltage supply. T F

5. What does BCD stand for?

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- B. Binary-Coded Decimal
- C. Binary-Converted Decimal
- D. Binary-Changed Decimal

6. Which number is in BCD form?

- A. 0101
- B. 1010
- C. Both of them.
- D. None of them.

7. How many inputs does a 74LS47 IC (BCD-to-seven-segment driver) take?

- A. 2
- B. 3
- C. 4
- D. 7

8. How many outputs does a 74LS47 IC (BCD-to-seven-segment driver) produce?

- A. 2
- B. 3
- C. 4
- D. 7

Name: _____
Date : 10/24
Class year: 2007

One Minute Digital Clock
Prelab

Please circle the correct answer.

1. The 555-Timer IC is:

- A. a digital circuit which is able to produce square waves.
- B. an electronic circuit which can be used as a digital watch.
- C. an integrated circuit which can produce oscillation.
- D. a counter which can count from 0 to 9 (decimal value).

$t = 2.1000 \Omega$
 $.693 \cdot 100 \cdot 10^{-9} F$
2

2. What is the value of resistance R2 in the following equation?

$$T = 0.693 \cdot C(R1 + 2 \cdot R2)$$

T = 1s
C = 100μF
R1 = 2k

R2 = 7214k

3. JK Flip-Flop is:

- A. a logic gate which is able to produce output 0 (low) or 1 (high).
- B. a digital circuit which consists of an inverter and NAND gates.
- C. an analog circuit which consists of a diode and some transistors.
- D. a digital circuit which functions as a digital switch.

4. True or False

- A. JK Flip-Flops operate normally without the clock signal. T F
- B. The state (0 or 1) of the output Q of a JK Flip-Flop is determined by the previous state of Q, the input J, and the input K. T F
- C. A Transistor-Transistor Logic Integrated Circuit (TTL IC) can have an odd number of pins. T F
- D. A Transistor-Transistor Logic Integrated Circuit (TTL IC) will not operate without being connected to a voltage supply. T F

5. What does BCD stand for?

- A. Binary-Called Decimal
- B. Binary-Coded Decimal
- C. Binary-Converted Decimal
- D. Binary-Changed Decimal

6. Which number is in BCD form?

- A. 0101
- B. 1010
- C. Both of them.
- D. None of them.

7. How many inputs does a 74LS47 IC (BCD-to-seven-segment driver) take?

- A. 2
- B. 3
- C. 4
- D. 7

8. How many outputs does a 74LS47 IC (BCD-to-seven-segment driver) produce?

- A. 2
- B. 3
- C. 4
- D. 7

Name: _____
Date : 02/06
Class year: 2017

One Minute Digital Clock
Prelab

Please circle the correct answer.

1. The 555-Timer IC is:

- A. a digital circuit which is able to produce square waves.
- B. an electronic circuit which can be used as a digital watch.
- C. an integrated circuit which can produce oscillation.
- D. a counter which can count from 0 to 9 (decimal value).

2. What is the value of resistance R2 in the following equation?

$$T = 0.693 \cdot C(R1 + 2 \cdot R2)$$

T = 1s
C = 100μF
R1 = 2k

Handwritten calculations:
$$\frac{1}{0.693} = 0.693 \cdot 100 (2 + 2 \cdot R2)$$
$$1.44 = 69.30 (2 + 2R2)$$
$$\frac{1.44}{69.30} = 2 + 2R2$$
$$0.0207 = 2 + 2R2$$
$$-2 = 2R2 + 0.0207 - 2$$
$$-2.0207 = 2R2$$
$$R2 = -1.01035$$

Note: The handwritten work shows a calculation for R2 that results in a negative value, which is likely a mistake. The correct calculation should be:
$$\frac{1}{0.693} = 0.693 \cdot 100 (2 + 2 \cdot R2)$$
$$1.44 = 69.30 (2 + 2R2)$$
$$\frac{1.44}{69.30} = 2 + 2R2$$
$$0.0207 = 2 + 2R2$$
$$-2 = 2R2 + 0.0207 - 2$$
$$-2.0207 = 2R2$$
$$R2 = -1.01035$$

3. JK Flip-Flop is:

- A. a logic gate which is able to produce output 0 (low) or 1 (high).
- B. a digital circuit which consists of an inverter and NAND gates.
- C. an analog circuit which consists of a diode and some transistors.
- D. a digital circuit which functions as a digital switch.

4. True or False

- A. JK Flip-Flops operate normally without the clock signal. T F
- B. The state (0 or 1) of the output Q of a JK Flip-Flop is determined by the previous state of Q, the input J, and the input K. T F
- C. A Transistor-Transistor Logic Integrated Circuit (TTL IC) can have an odd number of pins. T F
- D. A Transistor-Transistor Logic Integrated Circuit (TTL IC) will not operate without being connected to a voltage supply. T F

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- B. Binary-Coded Decimal
- C. Binary-Converted Decimal
- D. Binary-Changed Decimal

6. Which number is in BCD form?

- A. 0101
- B. 1010
- C. Both of them.
- D. None of them.

7. How many inputs does a 74LS47 IC (BCD-to-seven-segment driver) take?

- A. 2
- B. 3
- C. 4
- D. 7

8. How many outputs does a 74LS47 IC (BCD-to-seven-segment driver) produce?

- A. 2
- B. 3
- C. 4
- D. 7

Name: _____
Date: 10/24/04
Class year: 2007

$a = 40 \mu s$
 $\frac{da}{dt} = 8 \mu s$

One Minute Digital Clock
Prelab

Please circle the correct answer.

1. The 555-Timer IC is:

- A. a digital circuit which is able to produce square waves.
- B. an electronic circuit which can be used as a digital watch.
- C. an integrated circuit which can produce oscillation.
- D. a counter which can count from 0 to 9 (decimal value).

2. What is the value of resistance R2 in the following equation?

$$T = 0.693 \cdot C(R1 + 2 \cdot R2)$$

T = 1s
C = 100μF
R1 = 2k

1,000,000,000 F

3. JK Flip-Flop is:

- A. a logic gate which is able to produce output 0 (low) or 1 (high).
- B. a digital circuit which consists of an inverter and NAND gates.
- C. an analog circuit which consists of a diode and some transistors.
- D. a digital circuit which functions as a digital switch.

4. True or False

- A. JK Flip-Flops operate normally without the clock signal. T F
- B. The state (0 or 1) of the output Q of a JK Flip-Flop is determined by the previous state of Q, the input J, and the input K. T F
- C. A Transistor-Transistor Logic Integrated Circuit (TTL IC) can have an odd number of pins. T F
- D. A Transistor-Transistor Logic Integrated Circuit (TTL IC) will not operate without being connected to a voltage supply. T F

5. What does BCD stand for?

- A. Binary-Called Decimal
- B. Binary-Coded Decimal
- C. Binary-Converted Decimal
- D. Binary-Changed Decimal

6. Which number is in BCD form?

- A. 0101
- B. 1010
- C. Both of them.
- D. None of them.

7. How many inputs does a 74LS47 IC (BCD-to-seven-segment driver) take?

- A. 2
- B. 3
- C. 4
- D. 7

8. How many outputs does a 74LS47 IC (BCD-to-seven-segment driver) produce?

- A. 2
- B. 3
- C. 4
- D. 7

Name: _____
Date : 10/24
Class year: 12

One Minute Digital Clock
Prelab

Please circle the correct answer.

1. The 555-Timer IC is:

- A. a digital circuit which is able to produce square waves.
- B. an electronic circuit which can be used as a digital watch.
- C. an integrated circuit which can produce oscillation.
- D. a counter which can count from 0 to 9 (decimal value).

2. What is the value of resistance R2 in the following equation?

$$T = 0.693 \cdot C(R1 + 2 \cdot R2)$$

$$T = 1s$$
$$C = 100\mu F$$
$$R1 = 2k$$

$$1 = 0.693 \cdot 100E-6 (2 + 2 \cdot X)$$

3. JK Flip-Flop is:

- A. a logic gate which is able to produce output 0 (low) or 1 (high)
- B. a digital circuit which consists of an inverter and NAND gates.
- C. an analog circuit which consists of a diode and some transistors.
- D. a digital circuit which functions as a digital switch.

$$1 = 0.693 \cdot 100E-6 (2 + 2X)$$

4. True or False

- A. JK Flip-Flops operate normally without the clock signal. T F
- B. The state (0 or 1) of the output Q of a JK Flip-Flop is determined by the previous state of Q, the input J, and the input K. T F
- C. A Transistor-Transistor Logic Integrated Circuit (TTL IC) can have an odd number of pins. T F
- D. A Transistor-Transistor Logic Integrated Circuit (TTL IC) will not operate without being connected to a voltage supply. T F

5. What does BCD stand for?

- A. Binary-Called Decimal
- B. Binary-Coded Decimal
- C. Binary-Converted Decimal
- D. Binary-Changed Decimal

6. Which number is in BCD form?

- A. 0101
- B. 1010
- C. Both of them.
- D. None of them.

7. How many inputs does a 74LS47 IC (BCD-to-seven-segment driver) take?

- A. 2
- B. 3
- C. 4
- D. 7

8. How many outputs does a 74LS47 IC (BCD-to-seven-segment driver) produce?

- A. 2
- B. 3
- C. 4
- D. 7

Name: _____
Date : 10-25-06
Class year: 12

One Minute Digital Clock
Prelab

Please circle the correct answer.

1. The 555-Timer IC is:

- A. a digital circuit which is able to produce square waves.
- B. an electronic circuit which can be used as a digital watch.
- C. an integrated circuit which can produce oscillation.
- D. a counter which can count from 0 to 9 (decimal value).

2. What is the value of resistance R2 in the following equation?

$$T = 0.693 \cdot C(R1 + 2 \cdot R2)$$

T = 1s
C = 100μF
R1 = 2k

$1 = .1386 + 2 \cdot 10^{-4} R2$
 $R2 = 4307 \Omega$

3. JK Flip-Flop is:

- A. a logic gate which is able to produce output 0 (low) or 1 (high).
- B. a digital circuit which consists of an inverter and NAND gates.
- C. an analog circuit which consists of a diode and some transistors.
- D. a digital circuit which functions as a digital switch.

4. True or False

- A. JK Flip-Flops operate normally without the clock signal. T F
- B. The state (0 or 1) of the output Q of a JK Flip-Flop is determined by the previous state of Q, the input J, and the input K. T F
- C. A Transistor-Transistor Logic Integrated Circuit (TTL IC) can have an odd number of pins. T F
- D. A Transistor-Transistor Logic Integrated Circuit (TTL IC) will not operate without being connected to a voltage supply. T F

5. What does BCD stand for?

- A. Binary-Called Decimal
- B. Binary-Coded Decimal
- C. Binary-Converted Decimal
- D. Binary-Changed Decimal

6. Which number is in BCD form?

- A. 0101
- B. 1010
- C. Both of them.
- D. None of them.

7. How many inputs does a 74LS47 IC (BCD-to-seven-segment driver) take?

- A. 2
- B. 3
- C. 4
- D. 7

8. How many outputs does a 74LS47 IC (BCD-to-seven-segment driver) produce?

- A. 2
- B. 3
- C. 4
- D. 7

Name: _____
Date : 10/24/06
Class year: 2007

One Minute Digital Clock
Prelab

Please circle the correct answer.

1. The 555-Timer IC is:

- A. a digital circuit which is able to produce square waves.
- B. an electronic circuit which can be used as a digital watch.
- C. an integrated circuit which can produce oscillation.
- D. a counter which can count from 0 to 9 (decimal value).

2. What is the value of resistance R2 in the following equation?

$R2 = 8613$

$T = 0.693 \cdot C(R1 + 2 \cdot R2)$

$T = 1s$
 $C = 100\mu F$
 $R1 = 2k$

$T = (0.693) \cdot (100 \times 10^{-6}) (2k + 2 \cdot R2)$

$1 = (0.693) \cdot (2 + 2 \times 10^{-4} \cdot 100 \times 10^{-6} R)$

3. JK Flip-Flop is:

- A. a logic gate which is able to produce output 0 (low) or 1 (high).
- B. a digital circuit which consists of an inverter and NAND gates.
- C. an analog circuit which consists of a diode and some transistors.
- D. a digital circuit which functions as a digital switch.

4. True or False

- A. JK Flip-Flops operate normally without the clock signal. T F
- B. The state (0 or 1) of the output Q of a JK Flip-Flop is determined by the previous state of Q, the input J, and the input K. T F
- C. A Transistor-Transistor Logic Integrated Circuit (TTL IC) can have an odd number of pins. T F
- D. A Transistor-Transistor Logic Integrated Circuit (TTL IC) will not operate without being connected to a voltage supply. T F

5. What does BCD stand for?

- A. Binary-Called Decimal
- B. Binary-Coded Decimal
- C. Binary-Converted Decimal
- D. Binary-Changed Decimal

6. Which number is in BCD form?

- A. 0101
- B. 1010
- C. Both of them.
- D. None of them.

7. How many inputs does a 74LS47 IC (BCD-to-seven-segment driver) take?

- A. 2
- B. 3
- C. 4
- D. 7

8. How many outputs does a 74LS47 IC (BCD-to-seven-segment driver) produce?

- A. 2
- B. 3
- C. 4
- D. 7

Name: _____
Date : 2/27/20
Class year: senior (12)

5.5/9

One Minute Digital Clock
Prelab

Please circle the correct answer.

1. The 555-Timer IC is:

- A. a digital circuit which is able to produce square waves.
- B. an electronic circuit which can be used as a digital watch.
- C. an integrated circuit which can produce oscillation.
- D. a counter which can count from 0 to 9 (decimal value).

2. What is the value of resistance R2 in the following equation?

$$T = 0.693 \cdot C(R1 + 2 \cdot R2)$$

T = 1s
C = 100μF
R1 = 2k

$$\frac{T}{0.693 \cdot C(R1 + 2)} = R1 + 2 \cdot R2$$

$1.3 \times 10^{-1} \Omega$

3. JK Flip-Flop is:

- A. a logic gate which is able to produce output 0 (low) or 1 (high).
- B. a digital circuit which consists of an inverter and NAND gates.
- C. an analog circuit which consists of a diode and some transistors.
- D. a digital circuit which functions as a digital switch.

4. True or False

- A. JK Flip-Flops operate normally without the clock signal. T F
- B. The state (0 or 1) of the output Q of a JK Flip-Flop is determined by the previous state of Q, the input J, and the input K. T F
- C. A Transistor-Transistor Logic Integrated Circuit (TTL IC) can have an odd number of pins. T F
- D. A Transistor-Transistor Logic Integrated Circuit (TTL IC) will not operate without being connected to a voltage supply. T F

5. What does BCD stand for?

- A. Binary-Called Decimal
- B. Binary-Coded Decimal
- C. Binary-Converted Decimal
- D. Binary-Changed Decimal

6. Which number is in BCD form?

- A. 0101
- B. 1010
- C. Both of them.
- D. None of them.

7. How many inputs does a 74LS47 IC (BCD-to-seven-segment driver) take?

- A. 2
- B. 3
- C. 4
- D. 7

8. How many outputs does a 74LS47 IC (BCD-to-seven-segment driver) produce?

- A. 2
- B. 3
- C. 4
- D. 7

Name: f
Date: 10/24
Class year: 07

4.5/9

One Minute Digital Clock
Prelab

Please circle the correct answer.

1. The 555-Timer IC is:

- A. a digital circuit which is able to produce square waves.
- B. an electronic circuit which can be used as a digital watch.
- C. an integrated circuit which can produce oscillation.
- D. a counter which can count from 0 to 9 (decimal value).

2. What is the value of resistance R2 in the following equation?

$$T = 0.693 \cdot C(R1 + 2 \cdot R2)$$

T = 1s
C = 100 μ F
R1 = 2k

$$1s = 0.693 \cdot 100(2 + 2 \cdot x)$$
$$1 = 0.693(200 + 200 \cdot x)$$

3. JK Flip-Flop is:

- A. a logic gate which is able to produce output 0 (low) or 1 (high).
- B. a digital circuit which consists of an inverter and NAND gates.
- C. an analog circuit which consists of a diode and some transistors.
- D. a digital circuit which functions as a digital switch.

4. True or False

- A. JK Flip-Flops operate normally without the clock signal. F
- B. The state (0 or 1) of the output Q of a JK Flip-Flop is determined by the previous state of Q, the input J, and the input K. F
- C. A Transistor-Transistor Logic Integrated Circuit (TTL IC) can have an odd number of pins. F
- D. A Transistor-Transistor Logic Integrated Circuit (TTL IC) will not operate without being connected to a voltage supply. F

5. What does BCD stand for?

- A. Binary-Called Decimal
- B. Binary-Coded Decimal
- C. Binary-Converted Decimal
- D. Binary-Changed Decimal

6. Which number is in BCD form?

- A. 0101
- B. 1010
- C. Both of them.
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7. How many inputs does a 74LS47 IC (BCD-to-seven-segment driver) take?

- A. 2
- B. 3
- C. 4
- D. 7

8. How many outputs does a 74LS47 IC (BCD-to-seven-segment driver) produce?

- A. 2
- B. 3
- C. 4
- D. 7

One Minute Digital Clock

Postlab

8/9

Please circle the correct answer.

1. The 555-Timer IC can:
- A. perform counting mechanism.
 - B. operate as a clock.
 - C. take 4 inputs and produce 7 outputs.
 - D. produce a square wave at the output pin.

2. What is the value of the capacitance C in the following equation?

$$f = \frac{1}{0.693 \cdot C(R1 + 2 \cdot R2)}$$

f = 1Hz
 R1 = 7.5kΩ
 R2 = 3.0kΩ

$$1 = \frac{1}{0.693 \cdot C (7.5 \times 10^3 + 6.0 \times 10^3)}$$

$$1 = \frac{1}{C (9355.5)}$$

$$C = \frac{1}{9355.5} = 1.06889958 \times 10^{-4} \text{ F}$$

3. Decade counter 7490 IC:
- A. contains 4 JK flip-flops and some logic gates.
 - B. is able to count from 0 – 4 cyclically.
 - C. Both of them.
 - D. None of them.

4. True or False

- A. The 555 timer circuit provides a clock signal to the decade counter 7490.
- B. The output Q of a JK flip-flop does not depend on two inputs J and K.
- C. All Transistor-transistor logic integrated circuits have the same number of pins.
- D. The 74LS47 BCD driver takes 7 inputs and produces 4 outputs.

- T F ✓
- T F ✓
- T F ✓
- T F ✓

5. The total pins of a 7-segment display are:

- A. 4
- B. 7
- C. 8
- D. 10

6. Convert 8 (decimal value) to BCD form:

1000 ✓

7. What are the LSB - least significant bit and the MSB – most significant bit in the binary number 0101:

- A. LSB: 0, MSB: 0
- B. LSB: 0, MSB: 1
- C. LSB: 1, MSB: 0
- D. LSB: 1, MSB: 1

8. The 74LS47 BCD-to-seven-segment display driver:

- A. is able to count from 0 to 9 cyclically.
- B. is able to drive the seven segment displays.
- C. is able to take several inputs and produces an output.
- D. None of them.

One Minute Digital Clock

Postlab

Please circle the correct answer.

8/9

1. The 555-Timer IC can:
- A. perform counting mechanism.
 - B. operate as a clock.
 - C. take 4 inputs and produce 7 outputs.
 - D. produce a square wave at the output pin.

2. What is the value of the capacitance C in the following equation?

$$f = \frac{1}{0.693 \cdot C(R_1 + 2 \cdot R_2)}$$

f = 1Hz
 R1 = 7.5kΩ
 R2 = 3.0kΩ

$$f = \frac{1}{0.693 \cdot C(R_1 + 2R_2)}$$

C = 0.106mF ✓

f = 1

$$f \cdot (0.693 \cdot C(R_1 + 2R_2)) = 1$$

$$\frac{0.693 \cdot C(R_1 + 2R_2)}{0.693} = \frac{1}{0.693}$$

$$\frac{C(R_1 + 2R_2)}{R_1 + 2R_2} = \frac{1.443}{R_1 + 2R_2}$$

$$C = \frac{1.443}{7500 + 6000} = 0.106mF$$

3. Decade counter 7490 IC:
- A. contains 4 JK flip-flops and some logic gates.
 - B. is able to count from 0 - 4 cyclically.
 - C. Both of them.
 - D. None of them.
4. True or False
- A. The 555 timer circuit provides a clock signal to the decade counter 7490. T F
 - B. The output Q of a JK flip-flop does not depend on two inputs J and K. T F
 - C. All Transistor-transistor logic integrated circuits have the same number of pins. T F
 - D. The 74LS47 BCD driver takes 7 inputs and produces 4 outputs. T F

5. The total pins of a 7-segment display are:
- A. 4
 - B. 7
 - C. 8
 - D. 10

6. Convert 8 (decimal value) to BCD form: $\frac{1}{2^3} \frac{0}{2^2} \frac{0}{2^1} \frac{0}{2^0} \rightarrow 1000$ ✓

7. What are the LSB - least significant bit and the MSB - most significant bit in the binary number 0101:
- A. LSB: 0, MSB: 0
 - B. LSB: 0, MSB: 1
 - C. LSB: 1, MSB: 0
 - D. LSB: 1, MSB: 1

8. The 74LS47 BCD-to-seven-segment display driver:
- A. is able to count from 0 to 9 cyclically.
 - B. is able to drive the seven segment displays.
 - C. is able to take several inputs and produces an output.
 - D. None of them.

100

Name: Pravin H. R. V
Date: 10/3/16
Class year: C7

One Minute Digital Clock

Postlab

Please circle the correct answer.

1. The 555-Timer IC can:
- A. perform counting mechanism.
 - ✓ B. operate as a clock.
 - C. take 4 inputs and produce 7 outputs.
 - Ⓓ produce a square wave at the output pin.

9/9

2. What is the value of the capacitance C in the following equation?

$$f = \frac{1}{0.693 \cdot C(R1 + 2 \cdot R2)}$$

f = 1Hz
R1 = 7.5kΩ
R2 = 3.0kΩ

$$C = \frac{1}{0.693 \cdot f (R1 + 2 \cdot R2)}$$

$$C = \frac{1}{0.693 \cdot 1 \cdot (7.5 \cdot 10^3 + 2 \cdot 3 \cdot 10^3)}$$

$$C = \frac{1}{1.069 \cdot 10^{-4} f}$$

106.9 μf ✓

3. Decade counter 7490 IC:
- ✓ A. contains 4 JK flip-flops and some logic gates.
 - B. is able to count from 0 - 4 cyclically.
 - Ⓒ Both of them.
 - D. None of them.

4. True or False
- A. The 555 timer circuit provides a clock signal to the decade counter 7490.
 - B. The output Q of a JK flip-flop does not depend on two inputs J and K.
 - C. All Transistor-transistor logic integrated circuits have the same number of pins.
 - D. The 74LS47 BCD driver takes 7 inputs and produces 4 outputs.

Ⓓ F ✓
T Ⓕ ✓
T Ⓕ ✓
T Ⓕ ✓

5. The total pins of a 7-segment display are:
- A. 4
 - B. 7
 - C. 8
 - Ⓓ 10 ✓

6. Convert 8 (decimal value) to BCD form: 1000 ✓

7. What are the LSB - least significant bit and the MSB - most significant bit in the binary number 0101:
- A. LSB: 0, MSB: 0
 - B. LSB: 0, MSB: 1
 - ✓ Ⓒ LSB: 1, MSB: 0
 - D. LSB: 1, MSB: 1

8. The 74LS47 BCD-to-seven-segment display driver:
- ✓ A. is able to count from 0 to 9 cyclically.
 - Ⓓ is able to drive the seven segment displays.
 - C. is able to take several inputs and produces an output.
 - D. None of them.

One Minute Digital Clock

Postlab

8/9

Please circle the correct answer.

1. The 555-Timer IC can:
- A. perform counting mechanism.
 - B. operate as a clock.
 - C. take 4 inputs and produce 7 outputs.
 - D. produce a square wave at the output pin.

2. What is the value of the capacitance C in the following equation?

$$f = \frac{1}{0.693 \cdot C(R1 + 2 \cdot R2)}$$

f = 1Hz
 R1 = 7.5kΩ
 R2 = 3.0kΩ

Handwritten work for question 2:

$$1 \text{ Hz} = \frac{1}{0.693 \cdot C (7.5 \times 10^3 + 6 \times 10^3)}$$

~~1 Hz =~~

$$1 = \frac{1}{0.693 \cdot C (13.5 \times 10^3)}$$

$$1.35 \times 10^4 = 0.693 \cdot C$$

$$C = \frac{1.35 \times 10^4}{0.693} = 1.948 \times 10^4 \text{ F}$$

~~C = 2.27E-5~~

3. Decade counter 7490 IC:
- A. contains 4 JK flip-flops and some logic gates.
 - B. is able to count from 0 - 4 cyclically.
 - C. Both of them.
 - D. None of them.

4. True or False
- A. The 555 timer circuit provides a clock signal to the decade counter 7490.
 - B. The output Q of a JK flip-flop does not depend on two inputs J and K.
 - C. All Transistor-transistor logic integrated circuits have the same number of pins.
 - D. The 74LS47 BCD driver takes 7 inputs and produces 4 outputs.

Handwritten answers for question 4:

(T) F ✓
 T (F) ✓
 T (F) ✓
 T (F) ✓

5. The total pins of a 7-segment display are:
- A. 4
 - B. 7
 - C. 8
 - D. 10

6. Convert 8 (decimal value) to BCD form:
- 8 = 1000₂ ✓

7. What are the LSB - least significant bit and the MSB - most significant bit in the binary number 0101:
- A. LSB: 0, MSB: 0
 - B. LSB: 0, MSB: 1
 - C. LSB: 1, MSB: 0
 - D. LSB: 1, MSB: 1

8. The 74LS47 BCD-to-seven-segment display driver:
- A. is able to count from 0 to 9 cyclically.
 - B. is able to drive the seven segment displays.
 - C. is able to take several inputs and produces an output.
 - D. None of them.

One Minute Digital Clock

Postlab

Please circle the correct answer.

1. The 555-Timer IC can:

- A. perform counting mechanism.
- B. operate as a clock.
- C. take 4 inputs and produce 7 outputs.
- D. produce a square wave at the output pin.



2. What is the value of the capacitance C in the following equation?

$$f = \frac{1}{0.693 \cdot C(R1 + 2 \cdot R2)}$$

f = 1Hz
 R1 = 7.5kΩ
 R2 = 3.0kΩ

$$\frac{1}{0.693 \cdot f (R1 + 2 \cdot R2)} = \frac{1}{C}$$

C = 1.07 × 10⁻⁴ F ✓

7.5/9

3. Decade counter 7490 IC:

- A. contains 4 JK flip-flops and some logic gates.
- B. is able to count from 0 - 4 cyclically.
- C. Both of them.
- D. None of them.

4. True or False

A. The 555 timer circuit provides a clock signal to the decade counter 7490.

T F ✓

B. The output Q of a JK flip-flop does not depend on two inputs J and K.

T F ✗

C. All Transistor-transistor logic integrated circuits have the same number of pins.

T F ✓

D. The 74LS47 BCD driver takes 7 inputs and produces 4 outputs.

T F ✓

5. The total pins of a 7-segment display are:

- A. 4
- B. 7
- C. 8
- D. 10 ✓

6. Convert 8 (decimal value) to BCD form:

~~1000~~ 1000 ✓

7. What are the LSB - least significant bit and the MSB - most significant bit in the binary number 0101:

- A. LSB: 0, MSB: 0
- B. LSB: 0, MSB: 1
- C. LSB: 1, MSB: 0
- D. LSB: 1, MSB: 1

8. The 74LS47 BCD-to-seven-segment display driver:

- A. is able to count from 0 to 9 cyclically.
- B. is able to drive the seven segment displays.
- C. is able to take several inputs and produces an output.
- D. None of them.

Name: _____
 Date : 10/31/06
 Class year: 2007

One Minute Digital Clock

Postlab

6.5/9

Please circle the correct answer.

- The 555-Timer IC can:
 - A. perform counting mechanism.
 - B. operate as a clock.
 - C. take 4 inputs and produce 7 outputs.
 - D. produce a square wave at the output pin.
2. What is the value of the capacitance C in the following equation?

$$f = \frac{1}{0.693 \cdot C(R1 + 2 \cdot R2)}$$

f = 1Hz
 R1 = 7.5kΩ
 R2 = 3.0kΩ

$$f(0.693)(R1 + 2 \cdot R2) = \frac{1}{C}$$

$$C = \frac{1}{f(0.693)(R1 + 2 \cdot R2)}$$

$$C = \frac{1}{(1)(0.693)(7.5 \times 10^3 + 2 \cdot 3 \times 10^3)}$$

$$C = \frac{1}{(1)(0.693)(7.5 \times 10^3 + 6 \times 10^3)}$$

$$C = \frac{1}{(1)(0.693)(13500)}$$

$$C = \frac{1}{9355.5}$$

$$C = \frac{1}{9355.5} = 1.069 \times 10^{-4} \text{ F}$$

- Decade counter 7490 IC:
 - A. contains 4 JK flip-flops and some logic gates.
 - B. is able to count from 0 - 4 cyclically.
 - C. Both of them.
 - D. None of them.
4. True or False
 - A. The 555 timer circuit provides a clock signal to the decade counter 7490.
 - B. The output Q of a JK flip-flop does not depend on two inputs J and K.
 - C. All Transistor-transistor logic integrated circuits have the same number of pins.
 - D. The 74LS47 BCD driver takes 7 inputs and produces 4 outputs.

T F ✓

T F ✓

T F X

T F ✓

- The total pins of a 7-segment display are:
 - A. 4
 - B. 7
 - C. 8
 - D. 10 ✓

- Convert 8 (decimal value) to BCD form:

$$8_{10} = 1000_2 \quad \checkmark$$

- What are the LSB - least significant bit and the MSB - most significant bit in the binary number 0101:
 - A. LSB: 0, MSB: 0
 - B. LSB: 0, MSB: 1
 - C. LSB: 1, MSB: 0 ✓
 - D. LSB: 1, MSB: 1

- The 74LS47 BCD-to-seven-segment display driver:
 - A. is able to count from 0 to 9 cyclically. ✓
 - B. is able to drive the seven segment displays.
 - C. is able to take several inputs and produces an output.
 - D. None of them.



One Minute Digital Clock

Postlab

Name: _____
Date : 10-21-06
Class year: 07



Please circle the correct answer.

- The 555-Timer IC can:
 - A. perform counting mechanism.
 - B. operate as a clock.
 - C. take 4 inputs and produce 7 outputs.
 - D. produce a square wave at the output pin.

- What is the value of the capacitance C in the following equation?

$$C = \frac{1}{f \cdot 0.693 \cdot (R1 + 2 \cdot R2)}$$

f = 1Hz
R1 = 7.5kΩ
R2 = 3.0kΩ

clock power of 10

$$C = 1.07 \times 10^{-10} \mu F$$

- Decade counter 7490 IC:
 - A. contains 4 JK flip-flops and some logic gates.
 - B. is able to count from 0 – 4 cyclically.
 - C. Both of them.
 - D. None of them.

4. True or False

- A. The 555 timer circuit provides a clock signal to the decade counter 7490.
- B. The output Q of a JK flip-flop does not depend on two inputs J and K.
- C. All Transistor-transistor logic integrated circuits have the same number of pins.
- D. The 74LS47 BCD driver takes 7 inputs and produces 4 outputs.

T F ✓
T F ✗
T F ✓
T F ✓

5. The total pins of a 7-segment display are:

- A. 4
- B. 7
- C. 8
- D. 10

6. Convert 8 (decimal value) to BCD form:

1000 ✓

7. What are the LSB - least significant bit and the MSB – most significant bit in the binary number 0101:

- A. LSB: 0 , MSB: 0
- B. LSB: 0 , MSB: 1
- C. LSB: 1 , MSB: 0
- D. LSB: 1 , MSB: 1

8. The 74LS47 BCD-to-seven-segment display driver:

- A. is able to count from 0 to 9 cyclically.
- B. is able to drive the seven segment displays.
- C. is able to take several inputs and produces an output.
- D. None of them.

One Minute Digital Clock

Postlab

Please circle the correct answer.

6.5/9

- The 555-Timer IC can:
 - A. perform counting mechanism.
 - B. operate as a clock.
 - C. take 4 inputs and produce 7 outputs.
 - D. produce a square wave at the output pin.
2. What is the value of the capacitance C in the following equation?

$$f = \frac{1}{0.693 \cdot C(R1 + 2 \cdot R2)}$$

f = 1Hz
 R1 = 7.5kΩ
 R2 = 3.0kΩ

$$1 = \frac{1}{.693 \cdot C(7500 + 6000)}$$

$$C = \frac{1}{.693(7.5 + 60)} = 0.00089958$$

check power of 10

- Decade counter 7490 IC:
 - A. contains 4 JK flip-flops and some logic gates.
 - B. is able to count from 0 – 4 cyclically.
 - C. Both of them.
 - D. None of them.
4. True or False
 - A. The 555 timer circuit provides a clock signal to the decade counter 7490. T F
 - B. The output Q of a JK flip-flop does not depend on two inputs J and K. T F
 - C. All Transistor-transistor logic integrated circuits have the same number of pins. T F
 - D. The 74LS47 BCD driver takes 7 inputs and produces 4 outputs. T F

- The total pins of a 7-segment display are:
 - A. 4
 - B. 7
 - C. 8
 - D. 10

- Convert 8 (decimal value) to BCD form:

$$\frac{1}{8} \quad \frac{0}{4} \quad \frac{0}{2} \quad \frac{0}{1}$$

- What are the LSB - least significant bit and the MSB – most significant bit in the binary number 0101:
 - A. LSB: 0, MSB: 0
 - B. LSB: 0, MSB: 1
 - C. LSB: 1, MSB: 0
 - D. LSB: 1, MSB: 1

- The 74LS47 BCD-to-seven-segment display driver:
 - A. is able to count from 0 to 9 cyclically.
 - B. is able to drive the seven segment displays.
 - C. is able to take several inputs and produces an output.
 - D. None of them.

One Minute Digital Clock

Postlab

Please circle the correct answer.

1. The 555-Timer IC can:
- A. perform counting mechanism.
 - B. operate as a clock.
 - C. take 4 inputs and produce 7 outputs.
 - D. produce a square wave at the output pin.

$$f(0.693)(R_1 + 2 \cdot R_2) = 1$$

$$C(R_1 + 2 \cdot R_2) = 1.14$$

6/9

2. What is the value of the capacitance C in the following equation?

$$f = \frac{1}{0.693 \cdot C(R_1 + 2 \cdot R_2)}$$

f = 1Hz
 R1 = 7.5kΩ
 R2 = 3.0kΩ

$$C = \frac{1}{f(0.693)(R_1 + 2 \cdot R_2)}$$

$$C = \frac{1}{(1)(0.693)(7.5 \times 10^3 + (2)(3.0 \times 10^3))} = 1.07 \times 10^{-4} \text{ F}$$

3. Decade counter 7490 IC:
- A. contains 4 JK flip-flops and some logic gates.
 - B. is able to count from 0 - 4 cyclically.
 - C. Both of them.
 - D. None of them.

4. True or False
- A. The 555 timer circuit provides a clock signal to the decade counter 7490.
 - B. The output Q of a JK flip-flop does not depend on two inputs J and K.
 - C. All Transistor-transistor logic integrated circuits have the same number of pins.
 - D. The 74LS47 BCD driver takes 7 inputs and produces 4 outputs.

T F ✓
 T F ✓
 T F ✓
 T F ✓

5. The total pins of a 7-segment display are:
- A. 4
 - B. 7
 - C. 8
 - D. 10 ✓

6. Convert 8 (decimal value) to BCD form:

1000 ✓

7. What are the LSB - least significant bit and the MSB - most significant bit in the binary number 0101:
- A. LSB: 0, MSB: 0
 - B. LSB: 0, MSB: 1
 - C. LSB: 1, MSB: 0
 - D. LSB: 1, MSB: 1

8. The 74LS47 BCD-to-seven-segment display driver:
- A. is able to count from 0 to 9 cyclically.
 - B. is able to drive the seven segment displays.
 - C. is able to take several inputs and produces an output.
 - D. None of them.

One Minute Digital Clock

Postlab

Please circle the correct answer.

5.5/9

1. The 555-Timer IC can:

- A. perform counting mechanism.
- B. operate as a clock.
- X C. take 4 inputs and produce 7 outputs.
- D. produce a square wave at the output pin.

2. What is the value of the capacitance C in the following equation?

$$f = \frac{1}{0.693 \cdot C(R1 + 2 \cdot R2)}$$

f = 1Hz
 R1 = 7.5kΩ
 R2 = 3.0kΩ

7500Ω
 3000Ω

1 = $\frac{1}{.693 \cdot C(13500)}$

$1.068 \times 10^{-4} F$

$C = \frac{1}{.693 \cdot 13500}$

$\frac{1}{9355.5} = .000106$

3. Decade counter 7490 IC:

- A. contains 4 JK flip-flops and some logic gates.
- B. is able to count from 0 - 4 cyclically.
- X C. Both of them.
- D. None of them.

4. True or False

- A. The 555 timer circuit provides a clock signal to the decade counter 7490.
- B. The output Q of a JK flip-flop does not depend on two inputs J and K.
- C. All Transistor-transistor logic integrated circuits have the same number of pins.
- D. The 74LS47 BCD driver takes 7 inputs and produces 4 outputs.

- T F
- T F
- T F
- T F

5. The total pins of a 7-segment display are:

- A. 4
- B. 7
- C. 8
- D. 10

6. Convert 8 (decimal value) to BCD form:

1000 ✓

7. What are the LSB - least significant bit and the MSB - most significant bit in the binary number 0101:

- A. LSB: 0, MSB: 0
- B. LSB: 0, MSB: 1
- C. LSB: 1, MSB: 0
- D. LSB: 1, MSB: 1

8. The 74LS47 BCD-to-seven-segment display driver:

- A. is able to count from 0 to 9 cyclically.
- B. is able to drive the seven segment displays.
- X C. is able to take several inputs and produces an output.
- D. None of them.

One Minute Digital Clock

Postlab

4.5/9

Please circle the correct answer.

1. The 555-Timer IC can:
 A. perform counting mechanism.
 ✓ B. operate as a clock.
 C. take 4 inputs and produce 7 outputs.
 (D) produce a square wave at the output pin.

$f = \frac{1}{0.693 \cdot C \cdot (R1 + 2 \cdot R2)}$

2. What is the value of the capacitance C in the following equation?

$f = \frac{1}{0.693 \cdot C \cdot (R1 + 2 \cdot R2)}$

f = 1Hz
 R1 = 7.5kΩ
 R2 = 3.0kΩ

$(R1 + 2 \cdot R2) \cdot f = \frac{1}{C}$
 $C \cdot f = \frac{1}{(R1 + 2 \cdot R2)}$
 $C = \frac{1}{f \cdot (R1 + 2 \cdot R2)}$

$C = \frac{1}{(7.5 \cdot 10^3 + 2 \cdot 3 \cdot 10^3) \cdot 1}$
 $C = \frac{1}{13.5 \cdot 10^3}$
 $C = 7.4 \cdot 10^{-5} F$
 $C = 74 \mu F$

3. Decade counter 7490 IC:
 (A) contains 4 JK flip-flops and some logic gates.
 X B. is able to count from 0 – 4 cyclically.
 C. Both of them.
 D. None of them.

4. True or False
 A. The 555 timer circuit provides a clock signal to the decade counter 7490.
 B. The output Q of a JK flip-flop does not depend on two inputs J and K.
 C. All Transistor-transistor logic integrated circuits have the same number of pins.
 D. The 74LS47 BCD driver takes 7 inputs and produces 4 outputs.

(T) F ✓
 (T) F X
 T (F) ✓
 T (F) ✓

5. The total pins of a 7-segment display are:
 A. 4
 B. 7
 C. 8
 (D) 10 ✓

6. Convert 8 (decimal value) to BCD form:

8 = 1000 ✓

7. What are the LSB - least significant bit and the MSB – most significant bit in the binary number 0101:
 A. LSB: 0, MSB: 0
 X (B) LSB: 0, MSB: 1
 C. LSB: 1, MSB: 0
 D. LSB: 1, MSB: 1

8. The 74LS47 BCD-to-seven-segment display driver:
 A. is able to count from 0 to 9 cyclically.
 B. is able to drive the seven segment displays.
 X C. is able to take several inputs and produces an output.
 (D) None of them.

Name: _____
 Date: 10/31
 Class year: 07

One Minute Digital Clock

Postlab

Please circle the correct answer.

3/9

4/9

- The 555-Timer IC can:
 - perform counting mechanism.
 - operate as a clock.
 - take 4 inputs and produce 7 outputs.
 - produce a square wave at the output pin.
- What is the value of the capacitance C in the following equation?



$$f = \frac{1}{0.693 \cdot C(R1 + 2 \cdot R2)}$$

f = 1Hz
 R1 = 7.5kΩ
 R2 = 3.0kΩ

Handwritten scribbles and calculations:
 $C = \frac{1}{0.693 \cdot f(R1 + 2 \cdot R2)}$
 $C = \frac{1}{0.693 \cdot 1(7.5 + 2 \cdot 3)}$
 $C = \frac{1}{0.693 \cdot 13}$
 $C = \frac{1}{9.009}$
 $C \approx 0.111 \mu F$
 Additional scribbles include "0.693(R1 + 2R2)" and "0.693C".

- Decade counter 7490 IC:
 - contains 4 JK flip-flops and some logic gates.
 - is able to count from 0 - 4 cyclically.
 - Both of them.
 - None of them.
- True or False
 - The 555 timer circuit provides a clock signal to the decade counter 7490.
 - The output Q of a JK flip-flop does not depend on two inputs J and K.
 - All Transistor-transistor logic integrated circuits have the same number of pins.
 - The 74LS47 BCD driver takes 7 inputs and produces 4 outputs.

T (F) X
 (T) F X
 T (F) ✓
 T (F) ✓

- The total pins of a 7-segment display are:
 - 4
 - 7
 - 8
 - 10
- Convert 8 (decimal value) to BCD form:

$(X) = 8_{10}$

- What are the LSB - least significant bit and the MSB - most significant bit in the binary number 0101:
 - LSB: 0, MSB: 0
 - LSB: 0, MSB: 1
 - LSB: 1, MSB: 0
 - LSB: 1, MSB: 1
- The 74LS47 BCD-to-seven-segment display driver:
 - is able to count from 0 to 9 cyclically.
 - is able to drive the seven segment displays.
 - is able to take several inputs and produces an output.
 - None of them.

Name: _____
Date : _____
Class year: _____

4/9

One Minute Digital Clock

Prelab

Please circle the correct answer.

1. The 555-Timer IC is:

- A. a digital circuit which is able to produce square waves.
- B. an electronic circuit which can be used as a digital watch.
- C. an integrated circuit which can produce oscillation.
- D. a counter which can count from 0 to 9 (decimal value).

2. What is the value of resistance R2 in the following equation?

$$T = 0.693 \cdot C(R1 + 2 \cdot R2)$$

$$T = 1s$$
$$C = 100\mu F$$
$$R1 = 2k\Omega$$

$$1 = 0.693 \cdot (100 \times 10^{-6}) (400 + 2 \cdot R2)$$

~~R2 = 3652~~ R2 = 6215 Ω

3. JK Flip-Flop is:

- A. a logic gate which is able to produce output 0 (low) or 1 (high).
- B. a digital circuit which consists of an inverter and NAND gates.
- C. an analog circuit which consists of a diode and some transistors.
- D. a digital circuit which functions as a digital switch.

4. True or False

- A. JK Flip-Flops operate normally without the clock signal. T F
- B. The state (0 or 1) of the output Q of a JK Flip-Flop is determined by the previous state of Q, the input J, and the input K. T F
- C. A Transistor-Transistor Logic Integrated Circuit (TTL IC) can have an odd number of pins. T F
- D. A Transistor-Transistor Logic Integrated Circuit (TTL IC) will not operate without being connected to a voltage supply. T F

5. What does BCD stand for?

- A. Binary-Called Decimal
- B. Binary-Coded Decimal
- C. Binary-Converted Decimal
- D. Binary-Changed Decimal

6. Which number is in BCD form?

- A. 0101
- B. 1010
- C. Both of them.
- D. None of them.

7. How many inputs does a 74LS47 IC (BCD-to-seven-segment driver) take?

- A. 2
- B. 3

- C. 4
- D. 7

8. How many outputs does a 74LS47 IC (BCD-to-seven-segment driver) produce?

- A. 2
- B. 3
- C. 4
- D. 7

Name: _____
 Date: 12/19/67
 Class year: 11

2.5/9

One Minute Digital Clock

Prelab

Please circle the correct answer.

1. The 555-Timer IC is:

- A. a digital circuit which is able to produce square waves.
- B. an electronic circuit which can be used as a digital watch.
- C. an integrated circuit which can produce oscillation.
- D. a counter which can count from 0 to 9 (decimal value).

2. What is the value of resistance R2 in the following equation?

$$T = 0.693 \cdot C(R1 + 2 \cdot R2)$$

$T = 1s$
 $C = 100\mu F$
 $R1 = 2k\Omega$

Handwritten work:
 $0.693(100) = 2k + 2R2$
 $T = (0.693(100\mu F))(2k + (2R2))$

3. JK Flip-Flop is:

- A. a logic gate which is able to produce output 0 (low) or 1 (high).
- B. a digital circuit which consists of an inverter and NAND gates.
- C. an analog circuit which consists of a diode and some transistors.
- D. a digital circuit which functions as a digital switch.

Handwritten work:
 $R2 = 1k\Omega$
 $6.2k\Omega$
 $0.693(100) = 2k + (2R2)$
 $\frac{69.3}{2} = R2$

4. True or False

- A. JK Flip-Flops operate normally without the clock signal. T F
- B. The state (0 or 1) of the output Q of a JK Flip-Flop is determined by the previous state of Q, the input J, and the input K. T F
- C. A Transistor-Transistor Logic Integrated Circuit (TTL IC) can have an odd number of pins. T F
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- B. 3

- C. 4
- D. 7

8. How many outputs does a 74LS47 IC (BCD-to-seven-segment driver) produce?

- A. 2
- B. 3
- C. 4
- D. 7

$$1 = B(c) [X + (2Y)]$$

~~$$\frac{A}{B(c)} = [X + (2Y)]$$~~

~~$$\frac{1}{0.693(100)} = [R_1 + (2R_2)]$$~~

~~$$0.144 = (R_1 + 2R_2)$$~~

$$1 = 0.693(100) [2k + (2R_2)]$$

~~$$T = 0.693(100) [R_1 + (2R_2)]$$~~

Name: _____
Date : 1/19/07
Class year: _____

5/9

One Minute Digital Clock

Prelab

Please circle the correct answer.

1. The 555-Timer IC is:

- A. a digital circuit which is able to produce square waves.
- B. an electronic circuit which can be used as a digital watch.
- C. an integrated circuit which can produce oscillation.
- D. a counter which can count from 0 to 9 (decimal value).

✓

2. What is the value of resistance R2 in the following equation?

$$T = 0.693 \cdot C(R1 + 2 \cdot R2)$$

$$R_2 = 2138.5 \Omega$$

$$\begin{aligned} T &= 1s \\ C &= 100\mu F \\ R1 &= 2k\Omega \end{aligned} \quad T = \frac{T}{C} = 0.693 \cdot C(R1 + 2R2)$$

$$6.2k\Omega$$

$$R_2 = 0.693 \cdot C(R1 + 2T)$$

3. JK Flip-Flop is:

- A. a logic gate which is able to produce output 0 (low) or 1 (high).
- B. a digital circuit which consists of an inverter and NAND gates.
- C. an analog circuit which consists of a diode and some transistors.
- D. a digital circuit which functions as a digital switch.

✓

4. True or False

- A. JK Flip-Flops operate normally without the clock signal. T F
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- B. Binary-Coded Decimal
- C. Binary-Converted Decimal
- D. Binary-Changed Decimal

✓

6. Which number is in BCD form?

- A. 0101
- B. 1010
- C. Both of them.
- D. None of them.

7. How many inputs does a 74LS47 IC (BCD-to-seven-segment driver) take?

- A. 2
- B. 3

~~C.~~ 4
D. 17



8. How many outputs does a 74LS47 IC (BCD-to-seven-segment driver) produce?

- A. 2
- B. 3
- C. 4
- D. 7

74LS47

7
7
7

3

Name: _____
Date : 11-19-07
Class year: 11

5/9

One Minute Digital Clock

Prelab

Please circle the correct answer.

1. The 555-Timer IC is:

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- B. an electronic circuit which can be used as a digital watch.
- C. an integrated circuit which can produce oscillation.
- D. a counter which can count from 0 to 9 (decimal value).

2. What is the value of resistance R2 in the following equation?

$$T = 0.693 \cdot C(R1 + 2 \cdot R2)$$

$$\begin{aligned} T &= 1s \\ C &= 100\mu F \\ R1 &= 2k\Omega \end{aligned}$$

$$1 = .693 \times 100E^{-6} (2000 + 2R_2)$$

$$R_2 = 6215 \Omega$$

3. JK Flip-Flop is:

- A. a logic gate which is able to produce output 0 (low) or 1 (high).
- B. a digital circuit which consists of an inverter and NAND gates.
- C. an analog circuit which consists of a diode and some transistors.
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- B. Binary-Coded Decimal
- C. Binary-Converted Decimal
- D. Binary-Changed Decimal

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- D. None of them.

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- A. 2
- B. 3

- C. 4
- D. 7

8. How many outputs does a 74LS47 IC (BCD-to-seven-segment driver) produce?

- A. 2
- B. 3
- C. 4
- D. 7

Handwritten marks resembling a vertical list of checkmarks or scribbles on the left side of the page.

Name: Lu
Date : 1/14/01
Class year: 11

4.5/9

One Minute Digital Clock

Prelab

Please circle the correct answer.

1. The 555-Timer IC is:

- A. a digital circuit which is able to produce square waves.
- B. an electronic circuit which can be used as a digital watch.
- C. an integrated circuit which can produce oscillation.
- D. a counter which can count from 0 to 9 (decimal value).

2. What is the value of resistance R2 in the following equation?

$$T = 0.693 \cdot C(R1 + 2 \cdot R2)$$

T = 1s
C = 100μF
R1 = 2kΩ

6.2kΩ

3. JK Flip-Flop is:

- A. a logic gate which is able to produce output 0 (low) or 1 (high).
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- C. Binary-Converted Decimal
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7. How many inputs does a 74LS47 IC (BCD-to-seven-segment driver) take?

- A. 2
- B. 3

C. 4
D. 7

8. How many outputs does a 74LS47 IC (BCD-to-seven-segment driver) produce?

- A. 2
B. 3
C. 4
D. 7

e. 5 f. 2

0 1 1 1 1

Name: _____
Date : 1/19/09
Class year: 10021

7/9

One Minute Digital Clock

Prelab

Please circle the correct answer.

1. The 555-Timer IC is:

- A. a digital circuit which is able to produce square waves.
- B. an electronic circuit which can be used as a digital watch.
- C. an integrated circuit which can produce oscillation.
- D. a counter which can count from 0 to 9 (decimal value).

2. What is the value of resistance R2 in the following equation?

$$T = 0.693 \cdot C(R1 + 2 \cdot R2) \quad | = 0.693 \cdot 100 \mu F (2000 + 2 \cdot R2)$$

T = 1s
C = 100μF
R1 = 2kΩ

$R_2 = 6215.01 \Omega$
 $6.22K \Omega$

3. JK Flip-Flop is:

- A. a logic gate which is able to produce output 0 (low) or 1 (high).
- B. a digital circuit which consists of an inverter and NAND gates.
- C. an analog circuit which consists of a diode and some transistors.
- D. a digital circuit which functions as a digital switch.

4. True or False

- A. JK Flip-Flops operate normally without the clock signal. T F
- B. The state (0 or 1) of the output Q of a JK Flip-Flop is determined by the previous state of Q, the input J, and the input K. T F
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- C. Binary-Converted Decimal
- D. Binary-Changed Decimal

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- C. Both of them.
- D. None of them.

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- A. 2
- B. 3

- C. 4
- D. 7

8. How many outputs does a 74LS47 IC (BCD-to-seven-segment driver) produce?

- A. 2
- B. 3
- C. 4
- D. 7

Name: _____
Date : 1/14/01
Class year: _____

6/9

One Minute Digital Clock

Prelab

Please circle the correct answer.

1. The 555-Timer IC is:

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- D. a counter which can count from 0 to 9 (decimal value).

2. What is the value of resistance R2 in the following equation?

$$T = 0.693 \cdot C(R1 + 2 \cdot R2)$$

T = 1s
C = 100μF
R1 = 2kΩ

R2 = 6215 Ω ✓

1 = (0.693)(100)(2 + 2R2)

1 = (0.693)(2000 + 2R2)

~~1 = 0.693(2000 + 2R2)~~

~~1.98 = 2R2~~

14430 = 2000 + 2R2

12430 = 2R2

6215 = R2

3. JK Flip-Flop is:

- A. a logic gate which is able to produce output 0 (low) or 1 (high).
- B. a digital circuit which consists of an inverter and NAND gates.
- C. an analog circuit which consists of a diode and some transistors.
- D. a digital circuit which functions as a digital switch.

4. True or False

- A. JK Flip-Flops operate normally without the clock signal. T F
- B. The state (0 or 1) of the output Q of a JK Flip-Flop is determined by the previous state of Q, the input J, and the input K. T F
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- D. Binary-Changed Decimal

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- B. 1010
- C. Both of them.
- D. None of them.

7. How many inputs does a 74LS47 IC (BCD-to-seven-segment driver) take?

- A. 2
- B. 3

- C. 4
- D. 7



8. How many outputs does a 74LS47 IC (BCD-to-seven-segment driver) produce?

- A. 2
- B. 3
- C. 4
- D. 7



Nam. _____
Date : 1/19/06
Class year: _____

4/9

One Minute Digital Clock

Prelab

Please circle the correct answer.

1. The 555-Timer IC is:

- A. a digital circuit which is able to produce square waves.
- B. an electronic circuit which can be used as a digital watch.
- C. an integrated circuit which can produce oscillation.
- D. a counter which can count from 0 to 9 (decimal value).

2. What is the value of resistance R2 in the following equation?

$$T = 0.693 \cdot C(R1 + 2 \cdot R2)$$

$T = 1s$
 $C = 100\mu F$
 $R1 = 2k\Omega = 0.002$

$R2 = 138.7\Omega$ $6.2 k\Omega$

3. JK Flip-Flop is:

- A. a logic gate which is able to produce output 0 (low) or 1 (high).
- B. a digital circuit which consists of an inverter and NAND gates.
- C. an analog circuit which consists of a diode and some transistors.
- D. a digital circuit which functions as a digital switch.

4. True or False

- A. JK Flip-Flops operate normally without the clock signal. T F
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- D. None of them.

7. How many inputs does a 74LS47 IC (BCD-to-seven-segment driver) take?

- A. 2
- B. 3

- C. 4
- D. 7

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- A. 2
- B. 3
- C. 4
- D. 7

2.5.2

1
2
3
4

Name: M
Date : _____
Class year: _____

.100
2.5/9

One Minute Digital Clock

Prelab

Please circle the correct answer.

1. The 555-Timer IC is:

- A. a digital circuit which is able to produce square waves.
- B. an electronic circuit which can be used as a digital watch.
- C. an integrated circuit which can produce oscillation.
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2. What is the value of resistance R2 in the following equation?

$$T = 0.693 \cdot C(R1 + 2 \cdot R2)$$

T = 1s
C = 100 μ F
R1 = 2k Ω

6.2k Ω

$$T = .693 \cdot 100 (2,000 + 2 \cdot R_2)$$
$$69.3 (4,000) = 277200$$

3. JK Flip-Flop is:

- A. a logic gate which is able to produce output 0 (low) or 1 (high).
- B. a digital circuit which consists of an inverter and NAND gates.
- C. an analog circuit which consists of a diode and some transistors.
- D. a digital circuit which functions as a digital switch.

4. True or False

- A. JK Flip-Flops operate normally without the clock signal. T F ✓
- B. The state (0 or 1) of the output Q of a JK Flip-Flop is determined by the previous state of Q, the input J, and the input K. T F ✓
- C. A Transistor-Transistor Logic Integrated Circuit (TTL IC) can have an odd number of pins. T F ✓
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- A. 2
- B. 3

- 4
- D. 7

Q. 2.5

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- A. 2
- B. 3
- C. 4
- D. 7

Q. 2.5

Name: M
 Date: 11/9/07
 Class year: _____

5/9

One Minute Digital Clock

Prelab

Please circle the correct answer.

1. The 555-Timer IC is:

- A. a digital circuit which is able to produce square waves.
- B. an electronic circuit which can be used as a digital watch.
- C. an integrated circuit which can produce oscillation.
- D. a counter which can count from 0 to 9 (decimal value).

$$\frac{1}{.693} = .693 (100\mu F) (2000 + 2 \cdot R_2)$$

2. What is the value of resistance R2 in the following equation?

~~1.430~~

$$T = 0.693 \cdot C(R1 + 2 \cdot R2)$$

$T = 1s$
 $C = 100\mu F$
 $R1 = 2k\Omega$
 $R_2 = 6215.0072\Omega$

$$1430.0144 = (2000 + 2 \cdot R_2)$$

$$\frac{1443}{100\mu F} = (100\mu F)(2000 + 2 \cdot R_2)$$

$$\downarrow$$

$$14430.0144 = (2000 + 2 \cdot R_2)$$

$$-2000$$

$$\frac{12430}{2} = \frac{2 \cdot R_2}{2}$$

$$R_2 = 6215.0072$$

3. JK Flip-Flop is:

- A. a logic gate which is able to produce output 0 (low) or 1 (high).
- B. a digital circuit which consists of an inverter and NAND gates.
- C. an analog circuit which consists of a diode and some transistors.
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- A. 0101
- B. 1010
- C. Both of them.
- D. None of them.

A-C *
C-D

7. How many inputs does a 74LS47 IC (BCD-to-seven-segment driver) take?

- A. 2
- B. 3

C 4
D 7

8. How many outputs does a 74LS47 IC (BCD-to-seven-segment driver) produce?

- A. 2
- B. 3
- C. 4
- D. 7

Name _____
Date : 11/19/06
Class year: _____

scu

7/9

One Minute Digital Clock

Prelab

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$$T = 0.693 \cdot C(R1 + 2 \cdot R2)$$

T = 1s
C = 100μF
R1 = 2kΩ

$1 = 0.693 \cdot 0.000100(2000 + 2 \cdot R_2)$
 $1.443 = 0.000100(2000 + 2 \cdot R_2)$
 $14430 = 2000 + 2 \cdot R_2$
 $12430 = 2R_2$
 $R_2 = 6215 \checkmark$

3. JK Flip-Flop is:

- A. a logic gate which is able to produce output 0 (low) or 1 (high).
- B. a digital circuit which consists of an inverter and NAND gates.
- C. an analog circuit which consists of a diode and some transistors.
- D. a digital circuit which functions as a digital switch.

4. True or False

- A. JK Flip-Flops operate normally without the clock signal. T F
- B. The state (0 or 1) of the output Q of a JK Flip-Flop is determined by the previous state of Q, the input J, and the input K. T F
- C. A Transistor-Transistor Logic Integrated Circuit (TTL IC) can have an odd number of pins. T F
- D. A Transistor-Transistor Logic Integrated Circuit (TTL IC) will not operate without being connected to a voltage supply. T F

5. What does BCD stand for?

- A. Binary-Called Decimal
- B. Binary-Coded Decimal
- C. Binary-Converted Decimal
- D. Binary-Changed Decimal

6. Which number is in BCD form?

- A. 0101
- B. 1010
- C. Both of them.
- D. None of them.

7. How many inputs does a 74LS47 IC (BCD-to-seven-segment driver) take?

- A. 2
- B. 3

- C. 4
- D. 7



8. How many outputs does a 74LS47 IC (BCD-to-seven-segment driver) produce?

- A. 2
- B. 3
- C. 4
- D. 7



Name: Ni
Date: 1/19/07
Class year: _____

6/9

One Minute Digital Clock

Prelab

Please circle the correct answer.

1. The 555-Timer IC is:

- A. a digital circuit which is able to produce square waves.
- B. an electronic circuit which can be used as a digital watch.
- C. an integrated circuit which can produce oscillation.
- D. a counter which can count from 0 to 9 (decimal value).

2. What is the value of resistance R2 in the following equation?

$$T = 0.693 \cdot C(R1 + 2 \cdot R2)$$

T = 1s
C = 100μF
R1 = 2kΩ

Handwritten calculations:

$$14430 = 2000 + 2R2$$
$$12430 = 2R2 = 6215\Omega$$
$$1 = 0.693 \cdot 0.0001 (2000 + 2R2)$$
$$1 = 0.693 \cdot 0.0001 (2000 + 2R2)$$

3. JK Flip-Flop is:

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Name: _____
Date : _____
Class year: _____

6/9

One Minute Digital Clock

Prelab

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1. The 555-Timer IC is:

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- B. an electronic circuit which can be used as a digital watch.
- C. an integrated circuit which can produce oscillation.
- D. a counter which can count from 0 to 9 (decimal value).

2. What is the value of resistance R2 in the following equation?

$$T = \frac{1}{(643)(100 \times 10^{-6})}$$

$$T = 0.693 \cdot C(R1 + 2 \cdot R2)$$

$$T = 1s$$
$$C = 100\mu F$$
$$R1 = 2k\Omega$$

$$6,215 \Omega$$

3. JK Flip-Flop is:

- A. a logic gate which is able to produce output 0 (low) or 1 (high).
- B. a digital circuit which consists of an inverter and NAND gates.
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- A. JK Flip-Flops operate normally without the clock signal. T F ✓
- B. The state (0 or 1) of the output Q of a JK Flip-Flop is determined by the previous state of Q, the input J, and the input K. T F ✓
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A. 2
B. 3
C. 4
D. 7



Name _____
Date : _____
Class year: _____

One Minute Digital Clock

Prelab

4.5/9

Please circle the correct answer.

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- D. a counter which can count from 0 to 9 (decimal value).

2. What is the value of resistance R2 in the following equation?

$$T = 0.693 \cdot C(R1 + 2 \cdot R2)$$

T = 1s
C = 100μF
R1 = 2kΩ

6.2kΩ

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- C. 4
- D. 7



8. How many outputs does a 74LS47 IC (BCD-to-seven-segment driver) produce?

- A. 2
- B. 3
- C. 4
- D. 7

2.0

2.5K



Name: _____
Date : _____
Class year: _____

5/9

One Minute Digital Clock

Prelab

Please circle the correct answer.

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- C. an integrated circuit which can produce oscillation.
- D. a counter which can count from 0 to 9 (decimal value).

2. What is the value of resistance R2 in the following equation?

$$T = 0.693 \cdot C(R1 + 2 \cdot R2)$$

$$\begin{aligned} T &= 1s \\ C &= 100\mu F \\ R1 &= 2k\Omega \end{aligned}$$

6.2kΩ

1s = 0.693 * 100e-6 (2 + 2R2)

3. JK Flip-Flop is:

- A. a logic gate which is able to produce output 0 (low) or 1 (high).
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C. 4
D. 7

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- A. 2
- B. 3
- C. 4
- D. 7

74LS47

Name: _____
Date : 1-19-2023
Class year: 11

4/9

One Minute Digital Clock

Prelab

Please circle the correct answer.

1. The 555-Timer IC is:

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- C. an integrated circuit which can produce oscillation.
- D. a counter which can count from 0 to 9 (decimal value).

2. What is the value of resistance R2 in the following equation?

$$T = 0.693 \cdot C(R1 + 2 \cdot R2)$$

$$T = 1s$$

$$C = 100\mu F$$

$$R1 = 2k\Omega$$

$$R2 = 1k\Omega$$

$$1 = 0.693 \cdot$$

$$-100 =$$

$$\div 2$$

$$6.2k\Omega$$

3. JK Flip-Flop is:

- A. a logic gate which is able to produce output 0 (low) or 1 (high).
- B. a digital circuit which consists of an inverter and NAND gates.
- C. an analog circuit which consists of a diode and some transistors.
- D. a digital circuit which functions as a digital switch.

4. True or False

- A. JK Flip-Flops operate normally without the clock signal. T F
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- A. 2
- B. 3

- 4
- D. 7

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- A. 2
- B. 3
- C. 4
- 7

p.s.f.s

Name: _____
Date : _____
Class year: _____

3/9

One Minute Digital Clock

Prelab

Please circle the correct answer.

1. The 555-Timer IC is:

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- B. an electronic circuit which can be used as a digital watch.
- C. an integrated circuit which can produce oscillation.
- D. a counter which can count from 0 to 9 (decimal value).

2. What is the value of resistance R2 in the following equation?

$$T = 0.693 \cdot C(R1 + 2 \cdot R2)$$

$$\begin{aligned} T &= 1s \\ C &= 100\mu F \\ R1 &= 2k\Omega \end{aligned}$$

$$\frac{-138.6}{138.6} = -1$$

6.2k Ω

$$R2 = -1$$

3. JK Flip-Flop is:

- A. a logic gate which is able to produce output 0 (low) or 1 (high).
- B. a digital circuit which consists of an inverter and NAND gates.
- C. an analog circuit which consists of a diode and some transistors.
- D. a digital circuit which functions as a digital switch.

$$69.3(2 + 2R2) = 138.6 + 138.6R2$$

4. True or False

- A. JK Flip-Flops operate normally without the clock signal. T F
- B. The state (0 or 1) of the output Q of a JK Flip-Flop is determined by the previous state of Q, the input J, and the input K. T F
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7. How many inputs does a 74LS47 IC (BCD-to-seven-segment driver) take?

- A. 2
- B. 3

- C. 4
- D. 7

P/M

8. How many outputs does a 74LS47 IC (BCD-to-seven-segment driver) produce?

- A. 2
- B. 3
- C. 4
- D. 7

8. 5. 8

6

7

6

Name: _____
Date : 11/9/07
Class year: _____

3.5/9

One Minute Digital Clock

Prelab

Please circle the correct answer.

1. The 555-Timer IC is:

- A. a digital circuit which is able to produce square waves.
- B. an electronic circuit which can be used as a digital watch.
- C. an integrated circuit which can produce oscillation.
- D. a counter which can count from 0 to 9 (decimal value).

2. What is the value of resistance R2 in the following equation?

$$T = 0.693 \cdot C(R1 + 2 \cdot R2)$$

$T = 1s$
 $C = 100\mu F$
 $R1 = 2k\Omega$

$0.693 = 100 (2000 + 2 \cdot R2)$
 $1/100 = 69.3 (2002 R2)$
 $6.2 k\Omega$ $R2 = 28.9$

3. JK Flip-Flop is:

- A. a logic gate which is able to produce output 0 (low) or 1 (high).
- B. a digital circuit which consists of an inverter and NAND gates.
- C. an analog circuit which consists of a diode and some transistors.
- D. a digital circuit which functions as a digital switch.

4. True or False

- A. JK Flip-Flops operate normally without the clock signal. T F
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7. How many inputs does a 74LS47 IC (BCD-to-seven-segment driver) take?

- A. 2
- B. 3

C. 4 ✓
 D. 7

2/25

8. How many outputs does a 74LS47 IC (BCD-to-seven-segment driver) produce?

- A. 2
- B. 3
- C. 4
- D. 7

74LS47

Name: _____
 Date : _____
 Class year: _____

2.5/9

One Minute Digital Clock

Prelab

Please circle the correct answer.

1. The 555-Timer IC is:

- A. a digital circuit which is able to produce square waves.
- B. an electronic circuit which can be used as a digital watch.
- C. an integrated circuit which can produce oscillation.
- D. a counter which can count from 0 to 9 (decimal value).

$$R_2 = -.9928 K\Omega = 992.8\Omega$$

2. What is the value of resistance R2 in the following equation?

$$T = 0.693 \cdot C(R1 + 2 \cdot R2)$$

T = 1s
 C = 100μF
 R1 = 2kΩ

6.2kΩ

$$1s = 0.693 \cdot 100\mu F (2k\Omega + 2 \cdot R_2)$$

$$1.44 = 100\mu F (2k\Omega + 2 \cdot R_2)$$

$$100\mu F \quad 100\mu F$$

$$-2 \quad -2$$

$$-0.144 = (2k\Omega + 2 \cdot R_2)$$

$$-1.9856$$

3. JK Flip-Flop is:

- A. a logic gate which is able to produce output 0 (low) or 1 (high).
- B. a digital circuit which consists of an inverter and NAND gates.
- C. an analog circuit which consists of a diode and some transistors.
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- C. Both of them.
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7. How many inputs does a 74LS47 IC (BCD-to-seven-segment driver) take?

- A. 2
- B. 3

© 4
D. 7
P/2.5

8. How many outputs does a 74LS47 IC (BCD-to-seven-segment driver) produce?

- A. 2
- B. 3
- C. 4
- Ⓓ. 7 ✓

2+5.2

Name: M
Date: 11/20/07
Class year: junior

4/9

One Minute Digital Clock

Prelab

Please circle the correct answer.

1. The 555-Timer IC is:

- A. a digital circuit which is able to produce square waves.
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2. What is the value of resistance R2 in the following equation?

$$T = 0.693 \cdot C(R1 + 2 \cdot R2)$$

T = 1s
C = 100μF
R1 = 2kΩ

$$1 = .693(100 \times 10^{-6})(2000 + 2R_2)$$

~~0.02~~

$$14230 \cdot C_1 = 2000 + 2R_2$$

$$12430 \cdot 0.01 = 2R_2$$

$$6215 \Omega = R_2 \quad \checkmark$$

3. JK Flip-Flop is:

- A. a logic gate which is able to produce output 0 (low) or 1 (high).
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- C. Both of them.
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7. How many inputs does a 74LS47 IC (BCD-to-seven-segment driver) take?

- A. 2
- B. 3

- C. 4
- D. 7

8. How many outputs does a 74LS47 IC (BCD-to-seven-segment driver) produce?

- A. 2
- B. 3
- C. 4
- D. 7

Name _____
Date: 2/25/19
Class year: 2017

2.5/9

One Minute Digital Clock

Prelab

Please circle the correct answer.

1. The 555-Timer IC is:

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2. What is the value of resistance R2 in the following equation?

$$T = 0.693 \cdot C(R1 + 2 \cdot R2)$$

$$T = 1s$$

$$C = 100\mu F$$

$$R1 = 2k\Omega$$

$$R2 = 1k\Omega \quad 6.2k\Omega$$

3. JK Flip-Flop is:

- A. a logic gate which is able to produce output 0 (low) or 1 (high).
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- B. 3

- C. 4
- D. 7

8. How many outputs does a 74LS47 IC (BCD-to-seven-segment driver) produce?

- A. 2
- B. 3
- C. 4
- D. 7

0.5.5

0

✓

0

Name: _____
 Date : 1/19/27
 Class year: Junior

5/9

One Minute Digital Clock
 Prelab

Please circle the correct answer.

1. The 555-Timer IC is:

- A. a digital circuit which is able to produce square waves.
- B. an electronic circuit which can be used as a digital watch.
- C. an integrated circuit which can produce oscillation.
- D. a counter which can count from 0 to 9 (decimal value).

2. What is the value of resistance R2 in the following equation?

$R_2 = 6213$ ✓

$$T = 0.693 \cdot C(R_1 + 2 \cdot R_2)$$

$T = 1s$
 $C = 100\mu F$
 $R_1 = 2k\Omega$

$$\frac{1s}{0.693} = \frac{0.693}{0.693} \cdot 100\mu F^{-6} (2k\Omega + R_2)$$

$$\frac{1.44}{100\mu F^{-6}} = \frac{100\mu F^{-6}}{100\mu F^{-6}} (2k\Omega + 2 \cdot R_2)$$

$$\frac{14430}{200} = \frac{200}{200} (2000 + 2 \cdot R_2)$$

$$\frac{12430}{2} = \frac{2 \cdot R_2}{2} + \frac{2000}{2}$$

3. JK Flip-Flop is:

- A. a logic gate which is able to produce output 0 (low) or 1 (high).
- B. a digital circuit which consists of an inverter and NAND gates.
- C. an analog circuit which consists of a diode and some transistors.
- D. a digital circuit which functions as a digital switch.

4. True or False

- A. JK Flip-Flops operate normally without the clock signal. T F ✓
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- C. A Transistor-Transistor Logic Integrated Circuit (TTL IC) can have an odd number of pins. T F ✓
- D. A Transistor-Transistor Logic Integrated Circuit (TTL IC) will not operate without being connected to a voltage supply. T F ✓

5. What does BCD stand for?

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- B. Binary-Coded Decimal ✓
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- D. Binary-Changed Decimal

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- B. 1010
- C. Both of them.
- D. None of them.

7. How many inputs does a 74LS47 IC (BCD-to-seven-segment driver) take?

- A. 2
- B. 3

C. 4
 D. 7

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A. 2
B. 3
C. 4
 D. 7

Name: _____
Date : 1/19/06
Class year: _____

4/9

One Minute Digital Clock

Prelab

Please circle the correct answer.

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$$T = 0.693 \cdot C(R1 + 2 \cdot R2)$$

$$\begin{aligned} T &= 1s \\ C &= 100\mu F \\ R1 &= 2k\Omega \end{aligned}$$

$$\begin{aligned} 1s &= 0.693 \cdot 100\mu F (2k\Omega + 2 \cdot R2) \\ 1s &= 69.3\mu F (2k\Omega + 2 \cdot R2) \\ 0.01 &= 2k\Omega + 2R2 \\ -1.99 &= 2R2 \\ -1 &= R2 \end{aligned}$$

6.2k

3. JK Flip-Flop is:

- A. a logic gate which is able to produce output 0 (low) or 1 (high).
- B. a digital circuit which consists of an inverter and NAND gates.
- C. an analog circuit which consists of a diode and some transistors.
- D. a digital circuit which functions as a digital switch.

4. True or False

- A. JK Flip-Flops operate normally without the clock signal. T F
- B. The state (0 or 1) of the output Q of a JK Flip-Flop is determined by the previous state of Q, the input J, and the input K. T F
- C. A Transistor-Transistor Logic Integrated Circuit (TTL IC) can have an odd number of pins. T F
- D. A Transistor-Transistor Logic Integrated Circuit (TTL IC) will not operate without being connected to a voltage supply. T F

5. What does BCD stand for?

- A. Binary-Called Decimal
- B. Binary-Coded Decimal
- C. Binary-Converted Decimal
- D. Binary-Changed Decimal

6. Which number is in BCD form?

- A. 0101
- B. 1010
- C. Both of them.
- D. None of them.

7. How many inputs does a 74LS47 IC (BCD-to-seven-segment driver) take?

- A. 2
- B. 3

C. 4
 D. 7 ✓

8. How many outputs does a 74LS47 IC (BCD-to-seven-segment driver) produce?

- A. 2
- B. 3
- C. 4
- D. 7

2.5.2

7.5
+ 6.0
13.5

2/9

Post-test

Name: _____

Date : 2-27-07

Class year: 07

One Minute Digital Clock

Post-test

Please circle the correct answer.

1. The 555-Timer IC can:

- A. Performs as a counting mechanism.
- B. operates as a clock.
- C. takes 4 inputs and produces 7 outputs.
- D. produce a square wave at the output pin.

X

2. What is the value of the capacitance C in the following equation?

$$f = \frac{1}{0.693 \cdot C(R1 + 2 \cdot R2)}$$

f = 1Hz
 R1 = 7.5kΩ
 R2 = 3.0kΩ

1Hz $\frac{1}{0.693 \cdot C (7.5 + 2 \cdot 3.0)}$

$0.693 \cdot C (7.5 + 6)$

$\frac{0.693 \cdot C (13.5)}{0.693}$

$C = 19.4$

X

3. Decade counter 7490 IC:

- A. contains 4 JK flip-flops and some logic gates.
- B. is able to count from 0 - 4 cyclically.
- C. Both A & B.
- D. None of the above.

X

4. True or False

A. The 555 timer circuit provides a clock signal to the decade counter 7490.

T F

B. The output Q of a JK flip-flop does not depend on two inputs J and K.

T F

C. All Transistor-transistor logic integrated circuits have the same number of pins.

T F

D. The 74LS47 BCD driver takes 7 inputs and produces 4 outputs.

T F

5. The total pins of a 7-segment display are:

A. 4

B. 7

C. 8

D. 10

6. Convert 8 (decimal value) to BCD form:

0-0000	5-0101
1-0001	6-0110
2-0010	7-0111
3-0011	8-1000
4-0100	

7. What values are the LSB (least significant bit) and the MSB (most significant bit) in the binary number 0101:

A. LSB: 0 , MSB: 0

B. LSB: 0 , MSB: 1

C. LSB: 1 , MSB: 0

D. LSB: 1 , MSB: 1

8. The 74LS47 BCD-to-seven-segment display driver:

A. is able to count from 0 to 9 cyclically.

B. is able to drive the seven segment displays.

C. is able to take several inputs and produces a single output.

D. None of the above.

2.5/9

Post-test

Name: _____
Date : 2/27/07
Class year: 2006

One Minute Digital Clock

Post-test

Please circle the correct answer.

1. The 555-Timer IC can:

- A. Performs as a counting mechanism.
- B. operates as a clock.
- C. takes 4 inputs and produces 7 outputs.
- D. produce a square wave at the output pin.

X

2. What is the value of the capacitance C in the following equation?

$$f = \frac{1}{0.693 \cdot C(R1 + 2 \cdot R2)}$$

f = 1Hz
R1 = 7.5kΩ
R2 = 3.0kΩ

$$\frac{1}{C} = \frac{1}{0.693 \cdot 28.5}$$

$$\frac{1}{28.5} = 0.0351$$

$$\begin{array}{r} 0.693 \\ \times 28.5 \\ \hline 55440 \\ 138600 \\ \hline 197505 \end{array}$$

$$\frac{1}{C} = \frac{1}{19.75}$$

C = 19.75

X

3. Decade counter 7490 IC:

- A. contains 4 JK flip-flops and some logic gates.
- B. is able to count from 0 – 4 cyclically.
- C. Both A & B.
- D. None of the above.

X

4. True or False

A. The 555 timer circuit provides a clock signal to the decade counter 7490.

✓ T F

B. The output Q of a JK flip-flop does not depend on two inputs J and K.

✓ T F

C. All Transistor-transistor logic integrated circuits have the same number of pins.

✓ T F

X D. The 74LS47 BCD driver takes 7 inputs and produces 4 outputs.

T F

5. The total pins of a 7-segment display are:

A. 4

X B. 7

C. 8

D. 10

6. Convert 8 (decimal value) to BCD form:

X Binary Coded Decimal

7. What values are the LSB (least significant bit) and the MSB (most significant bit) in the binary number 0101:

A. LSB: 0, MSB: 0

✓ B. LSB: 0, MSB: 1

C. LSB: 1, MSB: 0

D. LSB: 1, MSB: 1

8. The 74LS47 BCD-to-seven-segment display driver:

X A. is able to count from 0 to 9 cyclically.

B. is able to drive the seven segment displays.

C. is able to take several inputs and produces a single output.

D. None of the above.

3.5/9

Post-test

Name: _____

Date : 2/27/07

Class year: 2008

One Minute Digital Clock

Post-test

Please circle the correct answer.

1. The 555-Timer IC can:

- A. Performs as a counting mechanism.
- B. operates as a clock.
- C. takes 4 inputs and produces 7 outputs.
- D. produce a square wave at the output pin.

2. What is the value of the capacitance C in the following equation?

$$f = \frac{1}{0.693 \cdot C(R1 + 2 \cdot R2)}$$

$$\begin{aligned} f &= 1\text{Hz} \\ R1 &= 7.5\text{k}\Omega \\ R2 &= 3.0\text{k}\Omega \end{aligned}$$

$$\frac{(c) 1\text{Hz}}{1\text{Hz}} = \frac{1}{0.693 \cdot C(7.5\text{k}\Omega + 2 \cdot 3.0\text{k}\Omega)} \text{ (Hz)}$$

$$C = \frac{1}{0.693(7.5\text{k}\Omega + 2 \cdot 3.0\text{k}\Omega)(1\text{Hz})}$$

$$C = 0.962$$

3. Decade counter 7490 IC:

- A. contains 4 JK flip-flops and some logic gates.
- B. is able to count from 0 – 4 cyclically.
- C. Both A & B.
- D. None of the above.

4. True or False

A. The 555 timer circuit provides a clock signal to the decade counter 7490.

T F

B. The output Q of a JK flip-flop does not depend on two inputs J and K.

T F

C. All Transistor-transistor logic integrated circuits have the same number of pins.

T F

D. The 74LS47 BCD driver takes 7 inputs and produces 4 outputs.

T F

5. The total pins of a 7-segment display are:

A. 4

B. 7

C. 8

D. 10

6. Convert 8 (decimal value) to BCD form:

8 => 1000

7. What values are the LSB (least significant bit) and the MSB (most significant bit) in the binary number 0101:

A. LSB: 0, MSB: 0

B. LSB: 0, MSB: 1

C. LSB: 1, MSB: 0

D. LSB: 1, MSB: 1

8. The 74LS47 BCD-to-seven-segment display driver:

A. is able to count from 0 to 9 cyclically.

B. is able to drive the seven segment displays.

C. is able to take several inputs and produces a single output.

D. None of the above.

3.5/9

Post-test

Name: _____

Date : 21/2/07

Class year: 08

One Minute Digital Clock

Post-test

Please circle the correct answer.

1. The 555-Timer IC can:

- A. Performs as a counting mechanism.
- B. operates as a clock.
- C. takes 4 inputs and produces 7 outputs.
- D. produce a square wave at the output pin.

2. What is the value of the capacitance C in the following equation?

$$f = \frac{1}{0.693 \cdot C(R1 + 2 \cdot R2)}$$

f = 1Hz
 R1 = 7.5kΩ
 R2 = 3.0kΩ

$$1 = \frac{1}{0.693 \cdot C(7500\Omega + 2 \cdot 3000\Omega)}$$

$$1 = \frac{1}{0.693 \cdot C(13500\Omega)}$$

$$0.693 = \frac{1}{C \cdot 13500}$$

$$9355.5 = \frac{1}{C}$$

$$C = \frac{1}{9355.5}$$

3. Decade counter 7490 IC:

- A. contains 4 JK flip-flops and some logic gates.
- B. is able to count from 0 – 4 cyclically.
- C. Both A & B.
- D. None of the above.

X

X

4. True or False

A. The 555 timer circuit provides a clock signal to the decade counter 7490.

T F

B. The output Q of a JK flip-flop does not depend on two inputs J and K.

T F

C. All Transistor-transistor logic integrated circuits have the same number of pins.

T F

D. The 74LS47 BCD driver takes 7 inputs and produces 4 outputs.

T F

5. The total pins of a 7-segment display are:

A. 4

B. 7

C. 8

D. 10

6. Convert 8 (decimal value) to BCD form:

1000

7. What values are the LSB (least significant bit) and the MSB (most significant bit) in the binary number 0101:

A. LSB: 0, MSB: 0

B. LSB: 0, MSB: 1

C. LSB: 1, MSB: 0

D. LSB: 1, MSB: 1

8. The 74LS47 BCD-to-seven-segment display driver:

A. is able to count from 0 to 9 cyclically.

B. is able to drive the seven segment displays.

C. is able to take several inputs and produces a single output.

D. None of the above.

3.5/9

Post-test

Name: K... ✓

Date : _____

Class year: 07

One Minute Digital Clock

Post-test

Please circle the correct answer.

1. The 555-Timer IC can:

- A. Performs as a counting mechanism.
- B. operates as a clock.
- ✓ C. takes 4 inputs and produces 7 outputs.
- ∅ D. produce a square wave at the output pin.

2. What is the value of the capacitance C in the following equation?

$$f = \frac{1}{0.693 \cdot C(R1 + 2 \cdot R2)}$$

- f = 1Hz
- R1 = 7.5kΩ
- R2 = 3.0kΩ

$$1 \text{ Hz} = \frac{1}{0.693 \cdot C (7.5 \text{ k}\Omega + 2 \cdot 3.0 \text{ k}\Omega)}$$

$$1 = \frac{0.693 \cdot C (7.5 \text{ k}\Omega + 2 \cdot 3.0 \text{ k}\Omega)}{1}$$

$$\frac{1.94}{13.5} = \frac{C (13.5 \text{ k}\Omega)}{13.5}$$

$$C = 0.157$$

3. Decade counter 7490 IC:

- ∅ A. contains 4 JK flip-flops and some logic gates.
- B. is able to count from 0 – 4 cyclically.
- ✓ C. Both A & B.
- D. None of the above.

4. True or False

A. The 555 timer circuit provides a clock signal to the decade counter 7490.

✓ ~~T~~ F

B. The output Q of a JK flip-flop does not depend on two inputs J and K.

X ~~T~~ F

C. All Transistor-transistor logic integrated circuits have the same number of pins.

✓ T ~~F~~

D. The 74LS47 BCD driver takes 7 inputs and produces 4 outputs.

✓ T ~~F~~

5. The total pins of a 7-segment display are:

A. 4

X B. 7

C. 8

(D) 10

6. Convert 8 (decimal value) to BCD form:

100

7. What values are the LSB (least significant bit) and the MSB (most significant bit) in the binary number 0101:

A. LSB: 0, MSB: 0

X B. LSB: 0, MSB: 1

(C) LSB: 1, MSB: 0

D. LSB: 1, MSB: 1

8. The 74LS47 BCD-to-seven-segment display driver:

X A. is able to count from 0 to 9 cyclically.

(B) is able to drive the seven segment displays.

C. is able to take several inputs and produces a single output.

D. None of the above.

3.5 | 9

Post-test

Name: _____ LT

Date : 2-27-07

Class year: 08'/11

One Minute Digital Clock

Post-test

Please circle the correct answer.

1. The 555-Timer IC can:

- A. Performs as a counting mechanism.
- B. operates as a clock.
- C. takes 4 inputs and produces 7 outputs.
- ✓ D. produce a square wave at the output pin.

2. What is the value of the capacitance C in the following equation?

$$f = \frac{1}{0.693 \cdot C(R1 + 2 \cdot R2)}$$

f = 1Hz
 R1 = 7.5kΩ
 R2 = 3.0kΩ

$$1\text{Hz} = \frac{1}{0.693 \cdot C(7.5\text{k}\Omega + 2 \cdot 3.0\text{k}\Omega)}$$

$$0.693 \cdot C(13.5\text{k}\Omega)$$

$$1\text{Hz} = \frac{1}{0.693 \cdot C(13.5\text{k}\Omega)}$$

X

C = 9.36 kΩ

9.36

3. Decade counter 7490 IC:

X

- A. contains 4 JK flip-flops and some logic gates.
- B. is able to count from 0 - 4 cyclically.
- ⓐ C. Both A & B.
- D. None of the above.

4. True or False

- A. The 555 timer circuit provides a clock signal to the decade counter 7490.
 T F
- B. The output Q of a JK flip-flop does not depend on two inputs J and K.
 T F ✓
- ~~C. All Transistor-transistor logic integrated circuits have the same number of pins.
 T F~~
- D. The 74LS47 BCD driver takes 7 inputs and produces 4 outputs.
 T F ✓

5. The total pins of a 7-segment display are:

- A. 4
B. 7
C. 8
✓ D. 10

6. Convert 8 (decimal value) to BCD form:

~~X~~ 466 1000

7. What values are the LSB (least significant bit) and the MSB (most significant bit) in the binary number 0101:

- A. LSB: 0, MSB: 0
~~X~~ B. LSB: 0, MSB: 1
 C. LSB: 1, MSB: 0
D. LSB: 1, MSB: 1

8. The 74LS47 BCD-to-seven-segment display driver:

- ~~X~~ A. is able to count from 0 to 9 cyclically.
 B. is able to drive the seven segment displays.
 C. is able to take several inputs and produces a single output.
D. None of the above.

Post-test

Name: _____

Date: 2/27/11Class year: 2008

One Minute Digital Clock

Post-test

Please circle the correct answer.

1. The 555-Timer IC can:

- A. Performs as a counting mechanism.
 B. operates as a clock.
 C. takes 4 inputs and produces 7 outputs.
 X D. produce a square wave at the output pin.

2. What is the value of the capacitance C in the following equation?

$$f = \frac{1}{0.693 \cdot C(R1 + 2 \cdot R2)}$$

$$f = 1\text{Hz}$$

$$R1 = 7.5\text{k}\Omega$$

$$R2 = 3.0\text{k}\Omega$$

$$C = .105$$

$$1 = \frac{1}{0.693 \cdot C(7.5\text{k} + 2 \cdot 3)}$$

$$C = \frac{1}{0.693 \cdot (13.5)}$$

$$1 = \frac{1}{9.3555}$$

$$C = 9.355$$

3. Decade counter 7490 IC:

- A. contains 4 JK flip-flops and some logic gates.
 B. is able to count from 0 – 4 cyclically.
 ✓ C. Both A & B.
 D. None of the above.

4. True or False

A. The 555 timer circuit provides a clock signal to the decade counter 7490.

T F

B. The output Q of a JK flip-flop does not depend on two inputs J and K.

T F

C. All Transistor-transistor logic integrated circuits have the same number of pins.

T F

D. The 74LS47 BCD driver takes 7 inputs and produces 4 outputs.

T F

5. The total pins of a 7-segment display are:

A. 4

B. 7

C. 8

D. 10

6. Convert 8 (decimal value) to BCD form:

1000 BCD

7. What values are the LSB (least significant bit) and the MSB (most significant bit) in the binary number 0101:

A. LSB: 0, MSB: 0

B. LSB: 0, MSB: 1

C. LSB: 1, MSB: 0

D. LSB: 1, MSB: 1

8. The 74LS47 BCD-to-seven-segment display driver:

A. is able to count from 0 to 9 cyclically.

B. is able to drive the seven segment displays.

C. is able to take several inputs and produces a single output.

D. None of the above.

3.5/9

Post-test

Name: _____

Date: 02/27/07

Class year: Juniors

One Minute Digital Clock

Post-test

Please circle the correct answer.

1. The 555-Timer IC can:

- (A) Performs as a counting mechanism.
- (B) operates as a clock.
- (C) takes 4 inputs and produces 7 outputs.
- (D) produce a square wave at the output pin.

X

2. What is the value of the capacitance C in the following equation?

$$f = \frac{1}{0.693 \cdot C(R1 + 2 \cdot R2)} \quad | = \frac{1}{0.693(C)(7.5 + 2(3))}$$

f = 1Hz
 R1 = 7.5kΩ
 R2 = 3.0kΩ

$$1 = \frac{1}{0.693(C)(13.5)}$$

X

$$F = \frac{1}{9.3555}$$

$$0.693(C)(13.5) = 1$$

$$(C) \frac{1}{9.3555} = \left(\frac{1}{9.3555} \right) = 1$$

3. Decade counter 7490 IC:

- A. contains 4 JK flip-flops and some logic gates.
- B. is able to count from 0 - 4 cyclically.
- C. Both A & B.
- D. None of the above.

X

9.3555

⁴
³
²
¹
 13.500
 x 0.693

 40500
 215000
 100000

 935500

4. True or False

A. The 555 timer circuit provides a clock signal to the decade counter 7490.

T F

B. The output Q of a JK flip-flop does not depend on two inputs J and K.

T F

C. All Transistor-transistor logic integrated circuits have the same number of pins.

T F

D. The 74LS47 BCD driver takes 7 inputs and produces 4 outputs.

T F

0001 - 1
0010 - 2
0011 - 3
0100 - 4
0101 - 5
0110 - 6
0111 - 7
1000 - 8

5. The total pins of a 7-segment display are:

A. 4

B. 7

C. 8

D. 10

6. Convert 8 (decimal value) to BCD form:

$$1000_2 = 8_{10}$$

7. What values are the LSB (least significant bit) and the MSB (most significant bit) in the binary number 0101:

A. LSB: 0, MSB: 0

B. LSB: 0, MSB: 1

C. LSB: 1, MSB: 0

D. LSB: 1, MSB: 1

8. The 74LS47 BCD-to-seven-segment display driver:

A. is able to count from 0 to 9 cyclically.

B. is able to drive the seven segment displays.

C. is able to take several inputs and produces a single output.

D. None of the above.

4.5/9

Post-test

Name: _____
Date : 2-21-07
Class year: 2007

One Minute Digital Clock

Post-test

Please circle the correct answer.

1. The 555-Timer IC can:

- A. Performs as a counting mechanism.
- B. operates as a clock.
- C. takes 4 inputs and produces 7 outputs.
- D. produce a square wave at the output pin.

2. What is the value of the capacitance C in the following equation?

$$f = \frac{1}{0.693 \cdot C(R1 + 2 \cdot R2)}$$

f = 1Hz
R1 = 7.5kΩ
R2 = 3.0kΩ

Handwritten calculations:

$$1\text{Hz} = \frac{1}{.693 \cdot C (13.5\text{k})}$$

$$1\text{Hz} (.693) (13.5\text{k}) = C$$

$$1\text{Hz} (9355.5) = C$$

3. Decade counter 7490 IC:

- A. contains 4 JK flip-flops and some logic gates.
- B. is able to count from 0 - 4 cyclically.
- C. Both A & B.
- D. None of the above.

4. True or False

A. The 555 timer circuit provides a clock signal to the decade counter 7490.

T F

B. The output Q of a JK flip-flop does not depend on two inputs J and K.

X T F

C. All Transistor-transistor logic integrated circuits have the same number of pins.

T F

D. The 74LS47 BCD driver takes 7 inputs and produces 4 outputs.

T F

5. The total pins of a 7-segment display are:

A. 4

B. 7

C. 8

D. 10

6. Convert 8 (decimal value) to BCD form:

1000

7. What values are the LSB (least significant bit) and the MSB (most significant bit) in the binary number 0101:

A. LSB: 0, MSB: 0

B. LSB: 0, MSB: 1

X C. LSB: 1, MSB: 0

D. LSB: 1, MSB: 1

8. The 74LS47 BCD-to-seven-segment display driver:

A. is able to count from 0 to 9 cyclically.

X B. is able to drive the seven segment displays.

C. is able to take several inputs and produces a single output.

D. None of the above.

4.5/9

Post-test

Name: _____
Date : _____
Class year: 2007

One Minute Digital Clock

Post-test

Please circle the correct answer.

1. The 555-Timer IC can:

- A. Performs as a counting mechanism.
- B. operates as a clock.
- C. takes 4 inputs and produces 7 outputs.
- D. produce a square wave at the output pin.

X

2. What is the value of the capacitance C in the following equation?

$$f = \frac{1}{0.693 \cdot C(R1 + 2 \cdot R2)}$$

$$1\text{Hz} = \frac{1}{0.693 \cdot C(R1 + 2 \cdot R2)}$$

- f = 1Hz
- R1 = 7.5kΩ
- R2 = 3.0kΩ

X

3. Decade counter 7490 IC:

- A. contains 4 JK flip-flops and some logic gates.
- B. is able to count from 0 - 4 cyclically.
- C. Both A & B.
- D. None of the above.

X

4. True or False

A. The 555 timer circuit provides a clock signal to the decade counter 7490.

X T F

B. The output Q of a JK flip-flop does not depend on two inputs J and K.

T F

C. All Transistor-transistor logic integrated circuits have the same number of pins.

T F

D. The 74LS47 BCD driver takes 7 inputs and produces 4 outputs.

T F

5. The total pins of a 7-segment display are:

A. 4

B. 7

C. 8

✓ D. 10

8
10
11
100
101
110
111
1000

6. Convert 8 (decimal value) to BCD form:

✓ 1000

7. What values are the LSB (least significant bit) and the MSB (most significant bit) in the binary number 0101:

A. LSB: 0, MSB: 0

B. LSB: 0, MSB: 1

✓ C. LSB: 1, MSB: 0

D. LSB: 1, MSB: 1

8. The 74LS47 BCD-to-seven-segment display driver:

X A. is able to count from 0 to 9 cyclically.

B. is able to drive the seven segment displays.

C. is able to take several inputs and produces a single output.

D. None of the above.

4.5/9

Post-test

Name: _____
Date : February 27, 2007
Class year: 11

One Minute Digital Clock

Post-test

Please circle the correct answer.

1. The 555-Timer IC can:
- A. Performs as a counting mechanism.
 - B. operates as a clock.
 - C. takes 4 inputs and produces 7 outputs.
 - D. produce a square wave at the output pin.

2. What is the value of the capacitance C in the following equation?

$$f = \frac{1}{0.693 \cdot C(R1 + 2 \cdot R2)}$$

f = 1Hz
R1 = 7.5kΩ
R2 = 3.0kΩ

$1\text{Hz} = \frac{1}{0.693 \cdot C(7.5\text{k}\Omega + 2 \cdot 3.0\text{k}\Omega)}$
 $1\text{Hz} = \frac{1}{0.693 \cdot C(13.5\text{k}\Omega)}$

X

3. Decade counter 7490 IC:
- A. contains 4 JK flip-flops and some logic gates.
 - B. is able to count from 0 – 4 cyclically.
 - C. Both A & B.
 - D. None of the above.

X

4. True or False

A. The 555 timer circuit provides a clock signal to the decade counter 7490.

T F

B. The output Q of a JK flip-flop does not depend on two inputs J and K.

T F

C. All Transistor-transistor logic integrated circuits have the same number of pins.

T F

D. The 74LS47 BCD driver takes 7 inputs and produces 4 outputs.

T F

5. The total pins of a 7-segment display are:

A. 4

B. 7

C. 8

D. 10

6. Convert 8 (decimal value) to BCD form:

1000

7. What values are the LSB (least significant bit) and the MSB (most significant bit) in the binary number 0101:

A. LSB: 0, MSB: 0

B. LSB: 0, MSB: 1

C. LSB: 1, MSB: 0

D. LSB: 1, MSB: 1

8. The 74LS47 BCD-to-seven-segment display driver:

A. is able to count from 0 to 9 cyclically.

B. is able to drive the seven segment displays.

C. is able to take several inputs and produces a single output.

D. None of the above.

5/9

Post-test

Name: _____ mark

Date : _____

Class year: 2

One Minute Digital Clock

Post-test

Please circle the correct answer.

1. The 555-Timer IC can:

- A. Performs as a counting mechanism.
- B. operates as a clock.
- ✓ C. takes 4 inputs and produces 7 outputs.
- ⓓ produce a square wave at the output pin.

2. What is the value of the capacitance C in the following equation?

$$f = \frac{1}{0.693 \cdot C(R1 + 2 \cdot R2)}$$

- f = 1Hz
- R1 = 7.5kΩ
- R2 = 3.0kΩ

$$0.693 \cdot C(R1 + 2 \cdot R2)$$

$$0.693 \cdot C(7.5 + 6)$$

$$0.693 \cdot C(13.5)$$

3. Decade counter 7490 IC:

- ⓐ contains 4 JK flip-flops and some logic gates.
- B. is able to count from 0 - 4 cyclically.
- ⓐ Both A & B.
- D. None of the above.

4. True or False

A. The 555 timer circuit provides a clock signal to the decade counter 7490.

✓ T F

B. The output Q of a JK flip-flop does not depend on two inputs J and K.

T F

C. All Transistor-transistor logic integrated circuits have the same number of pins.

✓ T F

D. The 74LS47 BCD driver takes 7 inputs and produces 4 outputs.

T F

5. The total pins of a 7-segment display are:

A. 4

B. 7

✓ C. 8

D. 10

6. Convert 8 (decimal value) to BCD form:

✓ $8 = 1000$

7. What values are the LSB (least significant bit) and the MSB (most significant bit) in the binary number 0101:

A. LSB: 0, MSB: 0

B. LSB: 0, MSB: 1

✓ C. LSB: 1, MSB: 0

D. LSB: 1, MSB: 1

8. The 74LS47 BCD-to-seven-segment display driver:

A. is able to count from 0 to 9 cyclically.

B. is able to drive the seven segment displays.

C. is able to take several inputs and produces a single output.

D. None of the above.

X

5.5/9

Post-test

Name: _____

Date : 2/27/07

Class year: 2007

One Minute Digital Clock

Post-test

Please circle the correct answer.

1. The 555-Timer IC can:

- A. Performs as a counting mechanism.
- B. operates as a clock.
- C. takes 4 inputs and produces 7 outputs.
- D. produce a square wave at the output pin.

2. What is the value of the capacitance C in the following equation?

$$f = \frac{1}{0.693 \cdot C(R1 + 2 \cdot R2)}$$

- f = 1Hz
- R1 = 7.5kΩ
- R2 = 3.0kΩ

$C = 1.17 \cdot 10^{-4} f$

$f = \frac{1}{0.693 \cdot C(7.5 + 2 \cdot 3)} = \frac{1}{0.693 \cdot C(13.5)}$

$\frac{1}{C} = 0.693 \cdot 13.5 \cdot f$

3. Decade counter 7490 IC:

- A. contains 4 JK flip-flops and some logic gates.
- B. is able to count from 0 - 4 cyclically.
- C. Both A & B.
- D. None of the above.

X

↑

4. True or False

A. The 555 timer circuit provides a clock signal to the decade counter 7490.

T F

B. The output Q of a JK flip-flop does not depend on two inputs J and K.

T F

C. All Transistor-transistor logic integrated circuits have the same number of pins.

T F

D. The 74LS47 BCD driver takes 7 inputs and produces 4 outputs.

T F

5. The total pins of a 7-segment display are:

A. 4

B. 7

C. 8

D. 10

6. Convert 8 (decimal value) to BCD form:

8 = 1000

7. What values are the LSB (least significant bit) and the MSB (most significant bit) in the binary number 0101:

A. LSB: 0, MSB: 0

B. LSB: 0, MSB: 1

C. LSB: 1, MSB: 0

D. LSB: 1, MSB: 1

8. The 74LS47 BCD-to-seven-segment display driver:

A. is able to count from 0 to 9 cyclically.

B. is able to drive the seven segment displays.

C. is able to take several inputs and produces a single output.

D. None of the above.

5.5/9

Post-test

Name: _____

Date : 2/22/17

Class year: _____

One Minute Digital Clock

Post-test

Please circle the correct answer.

1. The 555-Timer IC can:

- A. Performs as a counting mechanism.
- B. operates as a clock.
- C. takes 4 inputs and produces 7 outputs.
- D. produce a square wave at the output pin.

2. What is the value of the capacitance C in the following equation?

$$f = \frac{1}{0.693 \cdot C(R1 + 2 \cdot R2)}$$

$$f = 1\text{Hz}$$

$$R1 = 7.5\text{k}\Omega$$

$$R2 = 3.0\text{k}\Omega$$

$$1 = \frac{1}{(0.693)C(7.5\text{k}\Omega + 2(3.0\text{k}\Omega))}$$

$$1 = 1.5596628C$$

$$1.5596628C = 1$$

$$C = 1.5596628^{-1}$$

X

3. Decade counter 7490 IC:

- A. contains 4 JK flip-flops and some logic gates.
- B. is able to count from 0 - 4 cyclically.
- C. Both A & B.
- D. None of the above.

X

4. True or False

A. The 555 timer circuit provides a clock signal to the decade counter 7490.

~~T~~ F

B. The output Q of a JK flip-flop does not depend on two inputs J and K.

~~T~~ F

C. All Transistor-transistor logic integrated circuits have the same number of pins.

T ~~F~~

D. The 74LS47 BCD driver takes 7 inputs and produces 4 outputs.

T ~~F~~

5. The total pins of a 7-segment display are:

A. 4

B. 7

C. 8

~~D. 10~~

6. Convert 8 (decimal value) to BCD form:

1000

7. What values are the LSB (least significant bit) and the MSB (most significant bit) in the binary number 0101:

A. LSB: 0 , MSB: 0

B. LSB: 0 , MSB: 1

~~C. LSB: 1 , MSB: 0~~

D. LSB: 1 , MSB: 1

8. The 74LS47 BCD-to-seven-segment display driver:

~~A. is able to count from 0 to 9 cyclically.~~

B. is able to drive the seven segment displays.

~~C. is able to take several inputs and produces a single output.~~

D. None of the above.

5.5/9

Post-test

Name: _____

Date : 2-27-07

Class year: 2008

One Minute Digital Clock

Post-test

Please circle the correct answer.

1. The 555-Timer IC can:
- A. Performs as a counting mechanism.
 - B. operates as a clock.
 - C. takes 4 inputs and produces 7 outputs.
 - D. produce a square wave at the output pin.

2. What is the value of the capacitance C in the following equation?

$$f = \frac{1}{0.693 \cdot C(R1 + 2 \cdot R2)}$$

f = 1Hz
 R1 = 7.5kΩ
 R2 = 3.0kΩ

$$C \cdot 1 \text{ Hz} = \frac{1}{0.693 \cdot C(7,500\Omega + 2 \cdot 3000\Omega)}$$

$$(1 \text{ Hz})(C) = \frac{1}{0.693 \cdot (7500\Omega + 6000\Omega)}$$

$$C = 1.068 \times 10^{-4}$$

3. Decade counter 7490 IC:
- A. contains 4 JK flip-flops and some logic gates.
 - B. is able to count from 0 - 4 cyclically.
 - C. Both A & B.
 - D. None of the above.

X

4. True or False

A. The 555 timer circuit provides a clock signal to the decade counter 7490.

X T F

B. The output Q of a JK flip-flop does not depend on two inputs J and K.

T F

C. All Transistor-transistor logic integrated circuits have the same number of pins.

T F

D. The 74LS47 BCD driver takes 7 inputs and produces 4 outputs.

T F

5. The total pins of a 7-segment display are:

A. 4

B. 7

C. 8

X D. 10

6. Convert 8 (decimal value) to BCD form:

1000

7. What values are the LSB (least significant bit) and the MSB (most significant bit) in the binary number 0101:

A. LSB: 0, MSB: 0

B. LSB: 0, MSB: 1

X C. LSB: 1, MSB: 0

D. LSB: 1, MSB: 1

8. The 74LS47 BCD-to-seven-segment display driver:

A. is able to count from 0 to 9 cyclically.

B. is able to drive the seven segment displays.

C. is able to take several inputs and produces a single output.

D. None of the above.

6/9

Post-test

Name: _____
Date : 2/27/07
Class year: 2008

One Minute Digital Clock

Post-test

Please circle the correct answer.

1. The 555-Timer IC can:

- A. Performs as a counting mechanism.
- B. operates as a clock.
- C. takes 4 inputs and produces 7 outputs.
- D. produce a square wave at the output pin.

2. What is the value of the capacitance C in the following equation?

$$f = \frac{1}{0.693 \cdot C(R1 + 2 \cdot R2)}$$

f = 1Hz
 R1 = 7.5kΩ
 R2 = 3.0kΩ

$$1 = \frac{1}{0.693 \cdot C(7.5 + 2 \cdot 3)}$$

$$0.693 \cdot C(13.5) = 1$$

$$f = \frac{1}{0.693 \cdot C(R1 + 2 \cdot R2)}$$

$$f(R1 + 2 \cdot R2) = \frac{1}{0.693 \cdot C}$$

$$0.693 \cdot f(R1 + 2 \cdot R2) = \frac{1}{C}$$

$$(0.693)(1 \text{ Hz})$$

$$0.693(7.5 + 2(3))$$

$$0.693(13.5) = \frac{1}{C}$$

$$9.3555 = \frac{1}{C}$$

$$\frac{1}{9.3555} = C$$

$$C = \frac{1}{9.3555} = 1.068989958 \times 10^{-4} \text{ F}$$

3. Decade counter 7490 IC:

- A. contains 4 JK flip-flops and some logic gates.
- B. is able to count from 0 – 4 cyclically.
- C. Both A & B.
- D. None of the above.

4. True or False

A. The 555 timer circuit provides a clock signal to the decade counter 7490.

✓ T F

B. The output Q of a JK flip-flop does not depend on two inputs J and K.

✓ T F

C. All Transistor-transistor logic integrated circuits have the same number of pins.

✓ T F

✓ D. The 74LS47 BCD driver takes 7 inputs and produces 4 outputs.

T F

5. The total pins of a 7-segment display are:

A. 4

B. 7

X C. 8

D. 10

6. Convert 8 (decimal value) to BCD form:

$$8_{10} = 1000$$

7. What values are the LSB (least significant bit) and the MSB (most significant bit) in the binary number 0101:

A. LSB: 0, MSB: 0

B. LSB: 0, MSB: 1

C. LSB: 1, MSB: 0

D. LSB: 1, MSB: 1

8. The 74LS47 BCD-to-seven-segment display driver:

A. is able to count from 0 to 9 cyclically.

X B. is able to drive the seven segment displays.

C. is able to take several inputs and produces a single output.

D. None of the above.

Post-test

Name: _____
Date: 2/27/07
Class year: 08

One Minute Digital Clock

Post-test

Please circle the correct answer.

1. The 555-Timer IC can:

- A. Performs as a counting mechanism.
- B. operates as a clock.
- C. takes 4 inputs and produces 7 outputs.
- D. produce a square wave at the output pin.

2. What is the value of the capacitance C in the following equation?

$$f = \frac{1}{0.693 \cdot C(R1 + 2 \cdot R2)}$$

f = 1Hz

R1 = 7.5kΩ

R2 = 3.0kΩ

$$1 = \frac{1}{0.693 \cdot C(7.5k\Omega + 2(3k\Omega))}$$

$$1 = 0.693 \cdot C(13.5k\Omega)$$

$$\boxed{1.069 \times 10^{-4} F = C}$$

3. Decade counter 7490 IC:

- A. contains 4 JK flip-flops and some logic gates.
- B. is able to count from 0 – 4 cyclically.
- C. Both A & B.
- D. None of the above.

X

4. True or False

A. The 555 timer circuit provides a clock signal to the decade counter 7490.

T F

B. The output Q of a JK flip-flop does not depend on two inputs J and K.

T F

C. All Transistor-transistor logic integrated circuits have the same number of pins.

T F

D. The 74LS47 BCD driver takes 7 inputs and produces 4 outputs.

T F

5. The total pins of a 7-segment display are:

A. 4

B. 7

C. 8

D. 10

6. Convert 8 (decimal value) to BCD form:

10000

7. What values are the LSB (least significant bit) and the MSB (most significant bit) in the binary number 0101:

A. LSB: 0, MSB: 0

B. LSB: 0, MSB: 1

C. LSB: 1, MSB: 0

D. LSB: 1, MSB: 1

8. The 74LS47 BCD-to-seven-segment display driver:

A. is able to count from 0 to 9 cyclically.

B. is able to drive the seven segment displays.

C. is able to take several inputs and produces a single output.

D. None of the above.

Post-test

Name: _____

Date : 4/27/07

Class year: 2008

One Minute Digital Clock

Post-test

Please circle the correct answer.

1. The 555-Timer IC can:

- A. Performs as a counting mechanism.
- B. operates as a clock.
- C. takes 4 inputs and produces 7 outputs.
- D. produce a square wave at the output pin.

2. What is the value of the capacitance C in the following equation?

$$f = \frac{1}{0.693 \cdot C(R1 + 2 \cdot R2)}$$

- f = 1Hz
- R1 = 7.5kΩ
- R2 = 3.0kΩ

$$1 = \frac{1}{0.693 \cdot C(7500 + 2 \cdot 3000)}$$

$$C = .00011 \text{ F}$$

$$C = 110 \mu\text{F}$$

3. Decade counter 7490 IC:

- A. contains 4 JK flip-flops and some logic gates.
- B. is able to count from 0 - 4 cyclically. *is 0-4 counted in 0-9!*
- C. Both A & B.
- D. None of the above.

X



4. True or False

- A. The 555 timer circuit provides a clock signal to the decade counter 7490.
 T F *Should be: Saw wave*
- B. The output Q of a JK flip-flop does not depend on two inputs J and K.
 T F
- C. All Transistor-transistor logic integrated circuits have the same number of pins.
 T F
- D. The 74LS47 BCD driver takes 7 inputs and produces 4 outputs.
 T F

5. The total pins of a 7-segment display are:

- A. 4
- B. 7
- C. 8
- D. 10

6. Convert 8 (decimal value) to BCD form:

1000₂

7. What values are the LSB (least significant bit) and the MSB (most significant bit) in the binary number 0101:

X

- A. LSB: 0 , MSB: 0
- B. LSB: 0 , MSB: 1
- C. LSB: 1 , MSB: 0
- D. LSB: 1 , MSB: 1

8. The 74LS47 BCD-to-seven-segment display driver:

- A. is able to count from 0 to 9 cyclically.
- B. is able to drive the seven segment displays.
- C. is able to take several inputs and produces a single output.
- D. None of the above.

Post-test

Name: _____
Date : 2/27/07
Class year: _____

One Minute Digital Clock

Post-test

Please circle the correct answer.

1. The 555-Timer IC can:

- A. Performs as a counting mechanism.
- B. operates as a clock.
- C. takes 4 inputs and produces 7 outputs.
- D. produce a square wave at the output pin.

2. What is the value of the capacitance C in the following equation?

$$f = \frac{1}{0.693 \cdot C(R1 + 2 \cdot R2)}$$

f = 1Hz
R1 = 7.5kΩ
R2 = 3.0kΩ

$$1 \text{ Hz} = \frac{1}{.693 C (7500 + 6000)}$$

$$f(R1 + 2 \cdot R2) = \frac{1}{.693 \cdot C} \times .693$$

$$.693 f (R1 + 2 R2) = \frac{1}{C} \cdot \frac{1}{9355.5}$$

$$C = 1.06 \times 10^{-4} \text{ f}$$

3. Decade counter 7490 IC:

- A. contains 4 JK flip-flops and some logic gates.
- B. is able to count from 0 - 4 cyclically.
- C. Both A & B.
- D. None of the above.

X

4. True or False

A. The 555 timer circuit provides a clock signal to the decade counter 7490.

T F

B. The output Q of a JK flip-flop does not depend on two inputs J and K.

T F

C. All Transistor-transistor logic integrated circuits have the same number of pins.

T F

D. The 74LS47 BCD driver takes 7 inputs and produces 4 outputs.

T F

5. The total pins of a 7-segment display are:

A. 4

B. 7

C. 8

D. 10

6. Convert 8 (decimal value) to BCD form:

8 = 1000

7. What values are the LSB (least significant bit) and the MSB (most significant bit) in the binary number 0101:

A. LSB: 0, MSB: 0

B. LSB: 0, MSB: 1

C. LSB: 1, MSB: 0

D. LSB: 1, MSB: 1

8. The 74LS47 BCD-to-seven-segment display driver:

A. is able to count from 0 to 9 cyclically.

B. is able to drive the seven segment displays.

C. is able to take several inputs and produces a single output.

D. None of the above.

7.500

8/9

Post-test

Name: J. W.

Date: 2/27/07

Class year: _____

One Minute Digital Clock

Post-test

Please circle the correct answer.

1. The 555-Timer IC can:

- A. Performs as a counting mechanism.
- B. operates as a clock.
- C. takes 4 inputs and produces 7 outputs.
- D. produce a square wave at the output pin.

2. What is the value of the capacitance C in the following equation?

$$f = \frac{1}{0.693 \cdot C(R_1 + 2 \cdot R_2)}$$

$$1.443 = C(R_1 + 2 \cdot R_2)$$

$$1.443 = C(\cancel{7500} + 2 \cdot 3000)$$

$$f = 1\text{Hz}$$

$$R_1 = 7.5\text{k}\Omega$$

$$R_2 = 3.0\text{k}\Omega$$

$$C = 1.06 \times 10^{-4} \text{F}$$

3. Decade counter 7490 IC:

- A. contains 4 JK flip-flops and some logic gates.
- B. is able to count from 0 - 4 cyclically.
- C. Both A & B.
- D. None of the above.

X

4. True or False

A. The 555 timer circuit provides a clock signal to the decade counter 7490.

T F

B. The output Q of a JK flip-flop does not depend on two inputs J and K.

T F

C. All Transistor-transistor logic integrated circuits have the same number of pins.

T F

D. The 74LS47 BCD driver takes 7 inputs and produces 4 outputs.

T F

5. The total pins of a 7-segment display are:

A. 4

B. 7

C. 8

D. 10



6. Convert 8 (decimal value) to BCD form:

1000₈

7. What values are the LSB (least significant bit) and the MSB (most significant bit) in the binary number 0101:

A. LSB: 0, MSB: 0

B. LSB: 0, MSB: 1

C. LSB: 1, MSB: 0

D. LSB: 1, MSB: 1

8. The 74LS47 BCD-to-seven-segment display driver:

A. is able to count from 0 to 9 cyclically.

B. is able to drive the seven segment displays.

C. is able to take several inputs and produces a single output.

D. None of the above.

7/9

Post-test

Name: _____

Date : _____

Class year: _____

One Minute Digital Clock

Post-test

Please circle the correct answer.

1. The 555-Timer IC can:

- A. Performs as a counting mechanism.
- B. operates as a clock.
- C. takes 4 inputs and produces 7 outputs.
- D. produce a square wave at the output pin.

2. What is the value of the capacitance C in the following equation?

$$f = \frac{1}{0.693 \cdot C(R1 + 2 \cdot R2)}$$

- f = 1Hz
- R1 = 7.5kΩ
- R2 = 3.0kΩ

$$1 \text{ Hz} = \frac{1}{0.693 \cdot C (13500 \Omega)}$$

$$C = 1.069 \text{ E} - 4 \text{ F}$$

3. Decade counter 7490 IC:

- A. contains 4 JK flip-flops and some logic gates.
- B. is able to count from 0 - 4 cyclically.
- C. Both A & B.
- D. None of the above.

X

4. True or False

A. The 555 timer circuit provides a clock signal to the decade counter 7490.

T F

B. The output Q of a JK flip-flop does not depend on two inputs J and K.

T F

C. All Transistor-transistor logic integrated circuits have the same number of pins.

T F

D. The 74LS47 BCD driver takes 7 inputs and produces 4 outputs.

T F

5. The total pins of a 7-segment display are:

A. 4

B. 7

C. 8

D. 10

6. Convert 8 (decimal value) to BCD form:

1000₂

7. What values are the LSB (least significant bit) and the MSB (most significant bit) in the binary number 0101:

A. LSB: 0, MSB: 0

B. LSB: 0, MSB: 1

C. LSB: 1, MSB: 0

D. LSB: 1, MSB: 1

8. The 74LS47 BCD-to-seven-segment display driver:

A. is able to count from 0 to 9 cyclically.

B. is able to drive the seven segment displays.

C. is able to take several inputs and produces a single output.

D. None of the above.

X

Post-test

Na _____
Date : 2/27/07
Class year: _____

One Minute Digital Clock

Post-test

Please circle the correct answer.

1. The 555-Timer IC can:

- A. Performs as a counting mechanism.
- B. operates as a clock.
- C. takes 4 inputs and produces 7 outputs.
- D. produce a square wave at the output pin.

2. What is the value of the capacitance C in the following equation?

$$f = \frac{1}{0.693 \cdot C(R1 + 2 \cdot R2)}$$

f = 1Hz
 R1 = 7.5kΩ
 R2 = 3.0kΩ

$$1 = \frac{1}{(0.693)(C)(7500 + 6000)}$$

$$1 = \frac{1}{(0.693)(C)(13500)}$$

$$\frac{1}{1} = \frac{1}{(9355.5)(C)}$$

$$1 = (9355.5)(C)$$

$$C = 1.069 \times 10^{-4}$$

3. Decade counter 7490 IC:

- A. contains 4 JK flip-flops and some logic gates.
- B. is able to count from 0 - 4 cyclically.
- C. Both A & B.
- D. None of the above.

*

4. True or False

A. The 555 timer circuit provides a clock signal to the decade counter 7490.

T F

B. The output Q of a JK flip-flop does not depend on two inputs J and K.

T F

C. All Transistor-transistor logic integrated circuits have the same number of pins.

T F

✓ D. The 74LS47 BCD driver takes 7 inputs and produces 4 outputs.

T F

5. The total pins of a 7-segment display are:

A. 4

B. 7

C. 8

D. 10

6. Convert 8 (decimal value) to BCD form:

1000₂

7. What values are the LSB (least significant bit) and the MSB (most significant bit) in the binary number 0101:

A. LSB: 0, MSB: 0

B. LSB: 0, MSB: 1

C. LSB: 1, MSB: 0

D. LSB: 1, MSB: 1

8. The 74LS47 BCD-to-seven-segment display driver:

A. is able to count from 0 to 9 cyclically.

B. is able to drive the seven segment displays.

C. is able to take several inputs and produces a single output.

D. None of the above.