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| **TEXAS CTE LESSON PLAN**  [www.txcte.org](http://www.txcte.org) | |
| **Lesson Identification and TEKS Addressed** | |
| **Career Cluster** | Science, Technology, Engineering & Math |
| **Course Name** | Principles of Applied Engineering |
| **Lesson/Unit Title** | Microprocessor Basic Lesson |
| **TEKS Student Expectations** | **130.402. (c) Knowledge and Skills**  (2) The student investigates the components of engineering and  technology systems. The student is expected to:  (B) identify the inputs, processes, and outputs associated with technological systems  (C) describe the difference between open and close systems  (D) describe how technological systems interact to achieve common goals  (6) The student thinks critically and applies fundamental principles of system modeling and design to multiple design projects. The student is expected to:  (A) identify and describe the fundamental processes needed  for a project, including the design process and prototype  development and initiating, planning, executing, monitoring and controlling, and closing a project  (B) identify the chemical, mechanical, and physical properties of engineering materials  (C) use problem-solving techniques to develop technological  solutions  (D) use consistent units for all measurements and  computations  (7) The student understands the opportunities and careers in fields related to robotics, process control, and automation systems. The student is expected to:  (A) describe applications of robotics, process control, and  automation systems  (B) apply design concepts to problems in robotics, process  control, and automation systems  (C) identify fields and career opportunities related to robotics,  process control, and automation systems; and  (D) identify emerging trends in robotics, process control, and automation systems |
| **Basic Direct Teach Lesson**  (Includes Special Education Modifications/Accommodations and  one English Language Proficiency Standards (ELPS) Strategy) | |
| **Instructional Objectives** | The student will be able to:   1. Recall that transistors are the fundamental building block of all electronic devices 2. Explain how transistors are used to make logic gates 3. Describe how logic gates work as a circuit to perform defined functions 4. Recognize how we use truth tables to define the functions we want to perform 5. Identify the fundamentals of binary logic 6. List the basic parts that make up a computer and a microprocessor 7. Relate a general understanding of how a microprocessor actually works |
| **Rationale** | Investigates the components of engineering and technology systems. It also provides students to understand the opportunities and careers in fields related to robotics, process control, and automation systems. |
| **Duration of Lesson** | Teacher’s Discretion |
| **Word Wall/Key Vocabulary**  *(ELPS c1a, c, f; c2b; c3a, b, d; c4c; c5b) PDAS II (5)* |  |
| **Materials/Specialized Equipment Needed** | **Materials Needed:**   * Pen or pencil * A bare motherboard * A transistor   **Equipment Needed:**   * Computer * Projector   **Instructional Aids:**   * Technical Terms and Definitions handout for each student * Microprocessor Basics Quiz for each student * Microprocessor Basics Quiz Key |
| **Anticipatory Set**  (May include pre-assessment for prior knowledge) |  |
| **Direct Instruction \*** | **Introduction:**  **SAY:** We have learned some of the basics behind transistors, binary, and logic. We are now going to combine these to make more complicated devices like a microprocessor.  **ASK:** Has anyone looked inside a computer? The microprocessor is hard to see because it is hidden behind the cooling fan and heat sink, but we can see a lot about what a microprocessor actually does by looking at the motherboard itself. **SHOW:** The bare motherboard.  **SAY:** The motherboard looks pretty complicated, but there are a couple of general categories of things we can understand. There are a lot of other chips we can see. These connect a lot of the different devices together. Why we need a lot of different chips is because they all communicate differently, and these chips translate the signals from each device so they can talk together. By translate I mean change the size and speed of the data words.  **ASK:** Do you see all these wires? This is the way a computer communicates, by placingvoltage on wires. These wires connect everything together. **SHOW:** The transistor.  **SAY:** All the voltage on the wires goes to a device like this, called a transistor. What atransistor like this might do is turn on to put data into a memory location. **ASK:** Do you see these three leads?  **SAY:** It takes some type of electric circuit to make the transistor work right, but basically one ofthese leads is the power supply, one of these is the output, and one of these is a control signal on the input. These leads are labeled the emitter, base, and collector.  **Outline:**  If necessary, instructors are recommended to make a PowerPoint presentation in conjunction with the following outline. Use the attached handouts to facilitate the lesson.   * Review the operation of an inverter. It is designed to refresh the students understanding of how a transistor works.  This transistor works like a switch, turning on or off.When off, positive voltage from the power supply is coupled to the output.When on, ground is connected to the output and power supply voltage is dropped across the collector resistor.This is a simplified circuit, none of the output voltages are ideal.Most transistor circuits are a little more complicated than shown.They are designed to show the basics of operation. Then we show slightly more complicated circuits that are closer to circuits used.For the OR gate, without the diodes any voltage on one input will be transferred over to the other input.Other circuits also need to be modified to work better. **NOTE:** The concept of a voltage from one input feeding back to the  other input allows you to talk about input devices and output devices and how they connect. Voltage fed back to what should be the output of a circuit (in other words you are feeding an input into an output) can affect the operation of the circuit and violate the truth table. The truth table defines the logical operation we want, the physical circuit is built to perform that exact operation.The physical structure of a transistor (the N and P regions) are represented in a simpler form by the transistor schematic symbol.Transistor circuits we build to perform a logical operation are also represented in simpler form by other schematic symbols.The adder circuit itself is shown in schematic form as a box. **NOTE:** There is a kind of a hierarchy to schematic symbols. The complexity leads us to eventually show devices as “black boxes” that perform some function.   * There are seven total logic gates.  All the other logic gates are made up of the three basic gates.  * Each of the seven gates has unique truth table.   **NOTE:** We don’t show all of the other logic gates or their truth tables to keep from overwhelming the students, and they are not important to the operation of an adder circuit. However, you can introduce them if you like. In the decoder circuit, only one of the AND gate circuits produces a high output at a time.The one AND gate that is on depends on the binary code in.The one gate that turns on typically turns on some other circuit, like a memory circuit (shown), or some other circuit that produces outputs or looks for inputs.Codes do everything in a computer.An instruction is decoded by turning on a circuit that performs a specific set of actions in some sequence.Only that specific instruction (code) turns on the circuit that performs that sequence of actions.If you are starting to think that there must be a whole bunch of decoder circuits in a CPU you are starting to understand how a CPU works. **NOTE:** Our CD ROM can only send data into the CPU (or memory)  when the CPU asks for the data. The CPU asks for the data by enabling (turning on) the output of the CD ROM. A code is also used to turn on the memory location where the data goes. A computer has several basic parts a student needs to be able to understand.The CPU also has several internal parts (functions) that a student needs to know.Emphasize that the primary job of a microprocessor is to execute instructions.There is another device called a microcontroller that is not necessarily optimized to execute instructions.A microcontroller usually focuses on inputs and outputs to perform a specific function.Microprocessors and microcontrollers communicate with the outside world through the bus system.There are 3 primary groups of wires known as a bus: data, address, and control. Power and ground also use a group of wire, but may not be considered a busThe clock signals are one of the rare control signals that come from outside the CPU **NOTE:** There is a word document handout that describes in more  detail how a CPU works. You should  also do some online research to flesh out your own understanding.  *Individualized Education Plan (IEP) for all special education students must be followed. Examples of accommodations may include, but are not limited to:*  *NONE* |
| **Guided Practice \*** | **Guided Practice:**  Most of the guided practice involves memorizing. They need to draw schematic symbols, draw the truth tables, and be able to give definitions of things like a decoder. The parts of a computer and CPU must be memorized. They need to be given the terms and definitions, and they need to be reviewed frequently.  *Individualized Education Plan (IEP) for all special education students must be followed. Examples of accommodations may include, but are not limited to:*  *NONE* |
| **Independent Practice/Laboratory Experience/Differentiated Activities \*** | **Independent Practice:**  Review Terms and Definitions Worksheet and take mini quizzes  *Individualized Education Plan (IEP) for all special education students must be followed. Examples of accommodations may include, but are not limited to:*  *NONE* |
| **Lesson Closure** |  |
| **Summative/End of Lesson Assessment \*** | **Review:**  **Question:** What are TTL voltage levels?  **Answer:** + 5V and 0V.  *Question: What type of logic gate produces a high output when any input is high?*  **Question:** What is the difference between the schematic symbol of the OR gate vs the ANDgate?  **Answer:** The OR gate has a curved input side, the AND gate input side is straight.  **Question:** What are the two outputs of an adder?  **Answer:** The sum and the carry out.  **Question:** What is a decoder?  **Answer:** A circuit used to convert a multi-bit binary number input into an output that performsan action, like turn on a memory circuit.  **Question:** What are the two things a clock signal does?  **Answer:** Triggers the start of an operation, and defines the duration (or length of time) theoperation lasts.  **Informal Assessment:**  Technical Terms and Definitions handout. Students should write out definitions, draw truth tables, and list the different parts to each system given.  **Formal Assessment:**  Microprocessor Basics Quiz.  *Individualized Education Plan (IEP) for all special education students must be followed. Examples of accommodations may include, but are not limited to:*  *NONE* |
| **References/Resources/**  **Teacher Preparation** | * Read through Technical Terms and Definitions handout and Microprocessor quiz. * Goodheart-Willcox, *Electricity and Electronics* by Howard H. Gerrish, William E. Dugger, Jr., Richard M. Roberts * Cengage Learning Inc./Delmar (2008) *Engineering Design and Introduction*, by John R. Karsnitz, John P. Hutchinson, Stephen O’Brien * Use Wikipedia as a resource. |
| **Additional Required Components** | |
| **English Language Proficiency Standards (ELPS) Strategies** |  |
| **College and Career Readiness Connection[[1]](#footnote-1)** |  |
| **Recommended Strategies** | |
| **Reading Strategies** |  |
| **Quotes** |  |
| **Multimedia/Visual Strategy**  **Presentation Slides + One Additional Technology Connection** |  |
| **Graphic Organizers/Handout** |  |
| **Writing Strategies**  **Journal Entries + 1 Additional Writing Strategy** |  |
| **Communication**  **90 Second Speech Topics** |  |
| **Other Essential Lesson Components** | |
| **Enrichment Activity**  (e.g., homework assignment) |  |
| **Family/Community Connection** |  |
| **CTSO connection(s)** | Technology Student Association (TSA)  SkillsUSA |
| **Service Learning Projects** |  |
| **Lesson Notes** |  |

1. Visit the Texas College and Career Readiness Standards at <http://www.thecb.state.tx.us/collegereadiness/CRS.pdf>, Texas Higher Education Coordinating Board (THECB), 2009. [↑](#footnote-ref-1)