This in-class activity includes (2) activities.

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| **Purpose of this in-class activity** | As discussed in A04, Solar energy is a viable alternative to traditional energy sources such as coal or natural gas in certain situations. This activity is to provide hands-on experience collecting data relevant to solar energy utilizing the TI Kits. |

**Relevant Course Resources**:

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| Pre-Class Videos | * None yet |
| Course Resources | * [Getting Started with Energia and the TI Kits](https://engineering.purdue.edu/fye_i2i/i2i/ti-kit-activities/ti-kit-activities-getting-started/) * [Block Diagram Basics](https://engineering.purdue.edu/fye_i2i/wp-content/uploads/2022/08/Block-Diagram-Basics.pdf) |
| Lecture Slides | * Class 05A Slides |

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| **Debugging Strategies: Communication Errors between the TI Kits and Your Computer:**   1. Make sure that your TI Kit is plugged in correctly using the provided Micro USB to USB A cable. There should be a green power LED lit up when this occurs. 2. Is the COM port selected in Energia not the correct port? While it is generally the highest port number available. This is not always the case. All COM Ports should be tried if there are communication issues. 3. Ensure all drivers have been installed. For instructions on how to install, please see Step 2 in [Getting Started](https://engineering.purdue.edu/fye_i2i/ti-kit-activities-getting-started/). 4. Restart Energia IDE 5. Restart your computer (Should not be required, but can help depending on your computer’s settings)   **Submission Instructions:**   1. Re-name your answer sheet as, **ENGR131\_ICA04A\_*Team##*.docx**, where *team##* is your assigned ENGR 131 team. 2. Submit your work through the designated **Brightspace In-Class Activity Drop Box at** [https:/purdue.brightspace.com/](https://mycourses.purdue.edu/) |

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| **Task 2b** | **Communication between the TI Kit and Your Computer - Extracting Data from the Serial Port into Excel/CSV** |
| **Goal** | This task tests your ability to upload a sketch to the TI Kit board demonstrating that the TI kit can communicate with the computer. To do this, you will need to complete the following:   1. Open the Sketchbook/ENGR131/Activity 2 – Solar Project/Task2b\_light\_sensor\_excel file in Energia.   This image depicts the file location of the Task2b_light_sensor_excel sketch within the ENGR 131 file structure in the Energia IDE Sketchbook.  Figure 1: File Location of the Task2b\_Light\_sensor\_excel Sketch in Energia IDE’s sketchbook.   1. Before compiling and uploading the sketch, first you need to add to the board.    1. Connect the Grove Starter Kit Four Digit Digital Display to J14 of the Booster Pack using the four-prong connector cable.   This image depicts the Boosterpack connected to the four-digit display prior to mounting of the TI Kit.  Figure 2: Boosterpack with Light sensor and Four Digit Digital Display   * 1. Connect the Grove Starter Kit Light Sensor to J6 of the Boosterpack using the four-prong connector cable.   This image depicts the TI Kit Booster Pack with the light sensor and the four-digit display connected.  Figure 3: TI Kit Boosterpack connected to the Four-Digit Digital Display   * 1. If you haven’t already, connect the Boosterpack to your microcontroller.   This image depicts the TI Kit connected to the Boosterpack and the computer for power. Attached to the Boosterpack are the light sensor and the four-digit display.  Figure 4: TI Kit with attached Boosterpack connected to the Grove Starter Kit light sensor and four-digit digital display   1. Compile and upload the Light\_sensor\_excel sketch to your TI Kit.    1. **HINT:** If this works, there should be a changing red number should be illuminated on your Grove Starter Kit Four Digit Digital Display.    2. Open the Serial Monitor located in the Tools Menu to complete question 1.    3. Close the Serial Monitor. 2. Utilize the ArduSpreadsheet to record data from the serial port to an excel sheet.    1. Open ArduSpreadsheet located in the Tools Menu to complete question 2.   This image depicts the Tools dropdown menu in the Energia IDE. Highlighted is the Arduspreadsheet plug-in.  Figure 5: Energia IDE Tools Menu featuring the Arduspreadsheet plug-in  This image depicts the graphical user interface of the Arduspreadsheet plug-in for the Energia IDE.  Figure 6: Arduspreadsheet Plug-in Graphical User Interface (GUI)   * + 1. If you don’t see Arduspreadsheet located in tools, please follow these steps to install it        1. Download the ArduSpreadsheet zip file from [Getting Started](https://engineering.purdue.edu/fye_i2i/ti-kit-activities-getting-started/).        2. Extract the Arduspreadsheet zip file to the Energia/Tools Folder in your documents.   This image depicts the Arduspreadsheet zip file from downloads being extracted.  Figure 7: Arduspreadsheet zip folder extraction window   * 1. Close the ArduSpreadsheet.   Then answer the following questions:   1. Draw (by hand or via a computer) a block diagram of your set up on your answer document. 2. Take a picture of your TI Kit and booster back with the illuminated Grove Starter Kit Four Digit Digital Display visible and submit this in the answer document. 3. Take and upload a screenshot of the Serial Monitor window when 25 data points have been taken. 4. Using the ArduSpreadsheet plug-in, record 1 minute of data for your Grove Starter Kit Light Sensor in the Classroom. Save this data as a csv file and upload it with your answer document. The csv file should be named **ENGR131\_ICA04Ab\_*Team##*.csv** 5. Please take the raw data in your csv file and make a histogram of the data in excel. Screenshot this histogram with appropriate identifiers and add to your answer sheet. 6. Describe your histogram by the number of bins and bin width. |
| **Solution: Block Diagram** |  |
| **Solution: Picture** | This image depicts the TI kit connected to the Boosterpack with the light sensor and 4 digit digital display attached. It is utilizing the Task2a script. The four digit display is showing the readout in bits from the light sensor. |
| **Solution: Serial Monitor Plot** | This image depicts the serial monitor window exporting the light sensor reading. |
| **Solution: CSV File** | Upload the csv file with your answer sheet. |
| **Solution: Histogram** |  |
| **Solution: Histogram Analyis** | **How many bins does your histogram have:­­ .**  **What is the bin width of your histogram:­­ .** |
| **Reference: CODE** | /\*  Grove Light Sensor  A simple program that display the value of light from the Grove Light Sensor  on the Grove 4-Digit Display, this example is very similar to the Grove Rotary Angle Sensor example    The circuit:  \* 4-Digit Display attached to Pin 38 and 39 (J14 plug on Grove Base BoosterPack)  \* Light Sensor attached to Pin 24 (J6 plug on Grove Base BoosterPack)    \* Note:    Created by Oliver Wang    This example code is in the public domain.    http://www.seeedstudio.com/depot/Grove-Light-Sensor-p-746.html  \*/  //4-Digit Display library  #include "TM1637.h"  /\* Macro Define \*/  #define CLK 39 /\* 4-Digit Display clock pin \*/  #define DIO 38 /\* 4-Digit Display data pin \*/  #define LIGHT\_SENSOR 24 /\* pin connected to the Light Sensor \*/  /\* Global Variables \*/  TM1637 tm1637(CLK, DIO); /\* 4-Digit Display object \*/  int analog\_value = 0; /\* variable to store the value coming from Light Sensor \*/  int8\_t bits[4] = {0}; /\* array to store the single digits of the value \*/  int rowNumber=0; /\* Initializing the row number, seconds in which the excel file records the data  /\* the setup() method runs once, when the sketch starts \*/  void setup()  {  /\* Initialize 4-Digit Display \*/  tm1637.init();  tm1637.set(BRIGHT\_TYPICAL);  Serial.begin(9600);  }  /\* the loop() method runs over and over again \*/  void loop()  {  analog\_value = analogRead(LIGHT\_SENSOR); /\* read the value from the sensor \*/  Serial.print(++rowNumber);  Serial.print('\t');  Serial.println(analog\_value);    memset(bits, 0, 4); /\* reset array before we use it \*/  for(int i = 3; i >= 0; i--)  {  /\* Convert the value to individual decimal digits for display \*/  bits[i] = analog\_value % 10;  analog\_value = analog\_value / 10;  tm1637.display(i, bits[i]); /\* display value on 4-Digit Display \*/  }  delay(1000); //small delay so that the number doesn't change too quickly to read  } |

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| **Task 2c** | **Real World Data Collection - Tissue Paper Filter** |
| **Goal** | Now that you understand the basics of the Grove Starter Kit Light Sensor and how to extract data using it. You will now utilize it to obtain real world solar data simulating cloud cover on a sunny day using tissue paper. To do this, you will need to complete the following:   1. As in Task 2b, utilize the Grove Starter Kit Light Sensor and the ArduSpreadsheet plug-in. 2. Upload and compile the Light\_sensor\_excel file 3. Open the ArduSpreadsheet plug-in for use in question 1.   Then answer the following questions:   1. Record 1 minute of continuous data for each of the following cases:    1. Single Layer of Tissue Paper between light source and sensor    2. Fold the tissue paper in half (creating two layers) and place it between the light source and sensor    3. Fold the tissue paper in half again (creating four layers) and place it between the light source and sensor    4. Fold the tissue paper in half again (creating eight layers) and place it between the light source and sensor    5. Fold the tissue paper in half again (creating sixteen layers) and place it between the light source and sensor 2. Export the csv file and open it in Excel and perform the following conversion from bits to Lux (units of light). Save this data as an excel file and upload it with your answer document. The csv file should be named **ENGR131\_ICA04Ac\_*Team##*.xlsx**    1. Calculate the Voltage Drop using the following formula:    2. Convert the voltage drop to lux using the following formula:    3. **HINT:** Your excel sheet should have three columns: Raw Data, Voltage Drop, Lux |
| **Solution: Excel File** | Upload the excel file with your answer sheet. |
| **Reference: CODE** | /\*  Grove Light Sensor  A simple program that display the value of light from the Grove Light Sensor  on the Grove 4-Digit Display, this example is very similar to the Grove Rotary Angle Sensor example    The circuit:  \* 4-Digit Display attached to Pin 38 and 39 (J14 plug on Grove Base BoosterPack)  \* Light Sensor attached to Pin 24 (J6 plug on Grove Base BoosterPack)    \* Note:    Created by Oliver Wang    This example code is in the public domain.    http://www.seeedstudio.com/depot/Grove-Light-Sensor-p-746.html  \*/  //4-Digit Display library  #include "TM1637.h"  /\* Macro Define \*/  #define CLK 39 /\* 4-Digit Display clock pin \*/  #define DIO 38 /\* 4-Digit Display data pin \*/  #define LIGHT\_SENSOR 24 /\* pin connected to the Light Sensor \*/  /\* Global Variables \*/  TM1637 tm1637(CLK, DIO); /\* 4-Digit Display object \*/  int analog\_value = 0; /\* variable to store the value coming from Light Sensor \*/  int8\_t bits[4] = {0}; /\* array to store the single digits of the value \*/  int rowNumber=0; /\* Initializing the row number, seconds in which the excel file records the data  /\* the setup() method runs once, when the sketch starts \*/  void setup()  {  /\* Initialize 4-Digit Display \*/  tm1637.init();  tm1637.set(BRIGHT\_TYPICAL);  Serial.begin(9600);  }  /\* the loop() method runs over and over again \*/  void loop()  {  analog\_value = analogRead(LIGHT\_SENSOR); /\* read the value from the sensor \*/  Serial.print(++rowNumber);  Serial.print('\t');  Serial.println(analog\_value);    memset(bits, 0, 4); /\* reset array before we use it \*/  for(int i = 3; i >= 0; i--)  {  /\* Convert the value to individual decimal digits for display \*/  bits[i] = analog\_value % 10;  analog\_value = analog\_value / 10;  tm1637.display(i, bits[i]); /\* display value on 4-Digit Display \*/  }  delay(1000); //small delay so that the number doesn't change too quickly to read  } |