|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Assessment # and title | | | | IPRIOT-AT2-PT1 Intermediate IoT: Portfolio Part 1 | | | | | | | | |
| **Lecturer name** | | | | *Adrian Gould* | | | | | | | | |
| **Student name** | | | | *Nathan Bransby* | | | | | | | | |
| **Student ID number** | | | | *v141198@tafe.wa.edu.au* | | | | | | | | |
| **Telephone contact number** | | | | *N/A* | | | | | | | | |
| **Email** | | | | *v141198@tafe.wa.edu.au* | | | | | | | | |
| **By completing and submitting this signed form to my lecturer, I am stating that:**   1. The attached submission is completely my own work 2. I have correctly cited all sources of information used in this work (if required) 3. I have kept a copy of this assessment (where practicable) 4. I understand a copy of my assessment will be kept by the NMTAFE for their records 5. I understand my assessment may be selected for use in the NMTAFE’s validation and audit process to ensure student assessment meets requirements | | | | | | | | | | | | |
| **Student Signature** | | *Student to fill this section out* | | | | | | **Date** | | *Student to fill this section out* | | |
| Assessors please note: Where verbal clarification has been sought from a student to gather additional assessment evidence from an assessment item, question/s and response/s must be recorded, signed, and dated by the assessor, against the relevant assessment item/s. | | | | | | | | | | | | |
| NB: Feedback will be given via Blackboard when possible. | | | | | | | | | | | | |
| **Submission 1** | | Result | Satisfactory / Not Yet Satisfactory | | | | | | Date | | |  |
| *To satisfy requirements for this assessment, you need to complete the following:* | | | Feedback to student… | | | | | | | | | |
| **Submission 2** | | Result | Satisfactory / Not Yet Satisfactory | | | | | | Date | | |  |
| *To satisfy requirements for this assessment, you need to complete the following:* | | | Feedback to student… | | | | | | | | | |
| **Student Feedback** | | | Feedback from student… | | | | | | | | | |
| Lecturer Signature | | |  | | | | Student Signature | | | | |  |
| **Assessment type ():** | | | | | | | | | | | | |
|  | Questioning (Oral/Written) | | | |  | 3rd Party Report | | | | |  | Practical Demonstration |
|  | Other – Project/Portfolio (*please specify on the right):* | | | | Portfolio of work covering power consumption, GPIO, Sensors, Actuators and general IoT. | | | | | | | |

|  |
| --- |
| Requirements The base requirements for this assessment task may include one or more of the following:   * Web server, Python interpreter and database server * IDE or editor for developing Python programs (only PyCharm supported by the college) * Raspberry Pi with SenseHat or other IoT devices, like Arduino Uno or ESP32 * Access to Office 365 * Access to Microsoft Word * A calculator |
| Assessment Due This part of the portfolio assessment is split into components that have several due dates:   * Week 07 17:00 (5:00PM) on the day of the scheduled lecture.   Refer to Blackboard for most accurate dates, which may alter due to unforeseen circumstances.  Each part of the portfolio has a deadline for submission.  It is advantageous to you to attempt to meet the deadline provided.  We also will endeavour to update these document(s) at the same time. |
| Instructions Follow the steps listed in this assessment item.  Submission of the documentation, code, and associated items is at the end of each part of the portfolio. |
| Important If you are using a different configuration of tools and equipment for this assessment item, then assistance in this and subsequent parts of the portfolio to ensure the systems work correctly will be limited. |
| Scenario You are currently working for a small Perth-based start-up company called Incredibly Obvious Technologies.  They are looking to create a presence in the home automation and monitoring market.  Download and read the complete “Portfolio-Task-Scenario” from Blackboard. |
| General Instructions This document is to be used for submitting answers and evidence such as screen shots of your work.  Complete the document front page before continuing. |
| File Naming Conventions You are required to use a naming convention as outlined in Appendix XX.  Non-compliance will result in your attempt being deemed Not Yet Satisfactory. |
| Answering Questions When a step includes a question, you must attempt to answer it.  There is a minimum and maximum number of sentences to use for each answer.  All answer areas are provided with a recommended length of answer in sentences. These will vary in length.  Unless indicated, answers must be in complete sentences. |
| Sources of Information In industry, it is good practice to keep track of where information was obtained. This is especially true if it is a written document, or even code.  If you answer any questions using information from web sites, please include the site name and URL (Web site address) after the answer. Likewise, include the title and author for books and magazine articles. For example:   * RS Electronics Ltd: <https://au.rs-online.com/> * Slack API Documentation, Users List Method: <https://api.slack.com/methods/users.list> |
| Code Storage We advise that you create a GIT repository on GitHub and use this to store a copy of your work.  You may also use OneDrive within your college Office365 to store a backup of your code or keep a copy on a USB thumb drive. |

| Step | Task to Perform |
| --- | --- |
| 00 | Familiarisation and Setting Up Familiarise yourself with the content of this assessment by reading the whole document at least ONCE before commencing.  As you progress through the steps contained in this assessment document, add your answers, screen shots and other evidence in the areas marked Axx where A stands for answer, and xx is the step number.  For example, Step 00 (this one) has an answer area of A00.  Ensure you have followed the instructions on creating the answer document, as given in the General Instructions.  Make sure that you complete the title page of the document.  At any stage during this assignment, you may consult the stakeholder(s) or their representative(s).  All answer areas are provided with a recommended length of answer in sentences. These will vary in length.  Unless indicated, answers must be in complete sentences. |
| A00 | No Answer Required  *This space left intentionally blank.* |
| 01 | Power consumption of IoT devices (1) Research power consumption of the following devices:   * Raspberry Pi 4B * Raspberry Pi Zero W * Arduino Uno R4 * ESP32 * Raspberry Pi Pico W * ESP8285 * ESP8266   For each device, the default supply voltage has been provided.  Please note that the reported current may be a range (minimum and maximum), in which case provide the range in the form minimum – maximum.  For power consumption, calculate the minimum and maximum consumption based on the voltages and the current values found.  Always use the lowest current required that is not zero (as in the device is supplied with power). For example this may be in hibernation mode.  Remember: V = I × R  P = V × I  Where: V = Voltage (V, Volts),  I = Current (A, Amps),  R = Resistance (Ω, Ohms),  P = Power (W, Watts)  Enter your results in the table in the answer area A01. |
| A01 | Power requirements for MCU, SBC, SOC, CPU and FPGA Complete the table with the information required for the devices indicated.  Note:   * Imin (mA) Current (Minimum, milli Amps) * Imax (mA) Current (Maximum, milli Amps) * Pmin (mW) Power Consumption (Minimum, milli Watts)  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | **Type** | **Supply V** | **Circuit V** | **Imin (mA)** | **Imax (mA)** | **Pmin (mW)** | **Pmax (mW)** | | **Arduino Uno R4** | 6 - 24V | 5V | 0.4mA | 8mA | 2mW | 40mW | | **ESP32-WROVER** | 2.3-3.3V | 3.3V | 0.0001mA | 40mA | 0.00033mW | 132mW | | **Raspberry Pi Pico W** | 1.8-5.5V | 3.3V | 1.5mA | 300mA | 4.95mW | 990mW | | **ESP8285** | 2.7-3.6V | 3.3V | 0.0005mA | 12mA | 0.00165mW | 39.6mW | |
| 02 | Power consumption of IoT devices (2)  1. What are some of the key drivers (components, subsystems) of power consumption in IoT devices? 2. Provide at least three examples and provide an estimate of how much power is consumed by each (in mW). 3. For at least TWO of your examples mentioned in answer b, explain how you may mitigate this problem.   Enter your answers in the area marked A02. |
| A02 | Power consumption of IoT devices (2)What are some of the key drivers (components or subsystems) of power consumption in IoT devices (one example: Wi-Fi)?  (3 – 6 sentences)  1. **Sensors** 2. **Processors** 3. **Memory**  Provide at least three examples and provide an estimate of how much power is consumed by each (in mW). (3 – 6 sentences)  1. **Sensors** – Sensors (transducers) are components/devices that measure the physical input energy of specific and convert the readings into output energy.   *Example:*   * *Accelerometer – An accelerometer is an essential transducer needed in many modern IoT devices. The power consumption can vary with low current devices under normal operation reaching* [*4µA****¹***](https://www.electronicspecifier.com/products/sensors/accelerometer-boasts-ultra-low-power-consumption)*, and energy-saving mode as low as* [*800nA****¹***](https://www.electronicspecifier.com/products/sensors/accelerometer-boasts-ultra-low-power-consumption)*.*   *For a device with a voltage of 3.3V:*   * ***Pmax = 0.0132mW*** *(3.3V × 4 × 10ˉ⁶A =13.2 × 10ˉ⁶W = 13.2μW)* * ***Pmin = 0.00264mW*** *(3.3V × 0.8 × 10ˉ⁶A = 2.64 × 10ˉ⁶A = 2.64μW)*  1. **Processors** – In the core of all digital computing systems is some form of a Central Processing Unit (CPU). The CPU is made up of thousands of micro transistors that activate via machine code that process millions of instructions at a time.   *Example:*   * ***Device:*** *ESP-32 –**Like all digital computers, the ESP-32 contains a CPU at its core. Due to the low power (3.3V) supply required to operate, managing how much power is being delivered to to device is crucial. The way the ESP-32 manages the power consumption by [enabling different sleep/opertation modes](https://deepbluembedded.com/esp32-sleep-modes-power-consumption/" \l ":~:text=ESP32 Active mode current consumption,you're operating the microcontroller.)². A few of the operation modes and their consumption's are listed below:*  |  |  | | --- | --- | | **Operation Mode** | **Power Consumtion** *(mA)* | | Max-Speed (240MHz) | 30*mA ~ 68mA*³ | | Mid-Speed (160MHz) | *27mA ~ 44mA*³ | | Normal-Speed (80MHz) | 20*mA ~ 31mA*³ |  1. **Memory**  For at least TWO of your examples mentioned in answer b, explain how you may mitigate (reduce) the power consumption of the components?  (2 – 9 sentences total)  1. … 2. … 3. …  |  |  | | --- | --- | | **References** | | | Ref [1] | https://www.electronicspecifier.com/products/sensors/accelerometer-boasts-ultra-low-power-consumption | | *Ref:*  [2] | https://deepbluembedded.com/esp32-sleep-modes-power-consumption/#:~:text=ESP32%20Active%20mode%20current%20consumption,you're%20operating%20the%20microcontroller. | | Ref:  [3] | [https://www.espressif.com/sites/default/files/documentation/esp32\_datasheet\_en.pdf#page=18&zoom=100,76,401](https://www.espressif.com/sites/default/files/documentation/esp32_datasheet_en.pdf" \l "page=18&zoom=100,76,401) | Page 29 |Table 3.2. - Power Consumption by Power Modes. | |
| 03 | Power consumption of IoT devices (3)  1. In your own words, describe how you can calculate the theoretical maximum running time of a device given the capacity of a rechargeable battery. 2. What is the formula for calculating battery life (worst case scenario)? 3. Based on the results from Question 1, determine how long each device can run on various battery capacities.   Presume you are powering the device at its maximum current requirement with no external devices connected.  Presume the batteries are charged to their theoretical maximum, they are able to power the device until their charge is zero, and that the battery supplies the required voltage to the device. 4. Practically, batteries are not able to be charged to 100% and they have a minimum charge to allow them to function (and to be recharged).  Because the voltage of a battery drops when it runs out of charge, assume you have an effective charge of 90% of the provided value.   The battery may supply the device until its charge is 950mAh.  You may also assume that each battery has the correct supply voltage for each device.   Use the details above to calculate a “minimum” time for the devices to be run using the batteries.  Complete the table in the answer area. |
| A03 | Power consumption of IoT devices (3)In your own words, describe how you can calculate the running time of a device given the capacity of a rechargeable battery.  (3 – 10 sentences)Formula for calculating battery life (worst case scenario)Battery Life Table (To be completed)  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | **Type** | **Current Drain (max)** | **5000 mAh (max)** | **5000 mAh (reality)** | **22500 mAh (max)** | **22500 mAh (max)** | | **Raspberry Pi Pico W** |  |  |  |  |  | | **Raspberry Pi Zero 2 W** |  |  |  |  |  | | **Arduino Uno R4 WiFi** |  |  |  |  |  | | **ESP8285** |  |  |  |  |  | | **ESP32-WROOM** |  |  |  |  |  | |
| 04 | Reducing power consumption in IoT devices In your own words, describe the following power reduction strategies and name at least one disadvantage of each strategy:   1. Sleep 2. Deep Sleep 3. Hibernation   Enter your answers in the A04 area. |
| A04 | Reducing power consumption in IoT devices  * Each answer to have between 2 and 5 sentences. * Explain what each method does * Give at least ONE disadvantage for each of the power reduction methodologies.  SleepDeep SleepHibernation |
| 05 | Simple sensors For your first prototype, you are looking into detection to determine if a garage door is left open.  You want to use a ‘reed switch’ for this purpose.  This sensor contains a magnetically activated lever inside a glass tube. A small magnet opens the switch by bending the metal lever away from the contact.  A magnet with a red and white object  Description automatically generatedA screen shot of a phone  Description automatically generated  Answer the following questions:   1. In your own words, describe the operation of a reed switch and how you can use it to detect the open/close state of a door. 2. In your own words, describe how you might integrate this sensor (reed switch) to any one of the following devices:    * Raspberry Pi 4B    * Raspberry Pi Zero W    * Arduino Uno    * ESP32    * Raspberry Pi Pico W    * ESP8285    * ESP8266   The use of diagrams is allowed/encouraged to assist your answer. |
| A05 | Simple sensorsIn your own words, describe the operation of a reed switch and how you can use it to detect the open/close state of a door. (1 to 5 sentences)Integrating a reed switch with a IoT device. Diagrams are allowed/encouraged to assist your answer. (2 – 5 sentences) |
| 06 | External sensor “data” and IoT devices Sensors can deliver their readings in two forms.  One way is by digital signal, the other is by analogue signal.  Describe what is meant by the terms digital signal and analogue signal.  Identify an advantage of each type of signal.  You may illustrate your answer by using a simple sensor connected to an IoT device via GPIO.  Complete your answer in the A06 area on the following page. |
| A06 | External sensor `data` and IoT devicesWhat is a Digital Signal, and what is an advantage of this type of signal?  (2 – 6 sentences)What is an Analogue Signal, and what is an advantage of this type of signal?  (2 – 6 sentences) |
| 07 | Pull-Up and Pull-Down Resistors What is meant by a “floating signal”?  There are two ways to use a resistor to solve the floating problem using either a pull-up or a pull-down resistor.  In your own words, describe what the purpose of connecting a GPIO to these resistors, and what it achieves when there is no external signal applied to the GPIO:   1. a pull-up resistor, 2. a pull-down resistor.   Complete your answers in the A07 area on the following page. |
| A07 | Pull-Up and Pull-Down ResistorsWhat is meant by a “floating signal”?  (1 – 2 sentences)Purpose and effect of Pull-up resistor and the effect when no external signal is present on the GPIO. (2 – 4 sentences)Purpose of Pull-down resistor and the effect when no external signal is present GPIO.  (2 – 4 sentences) |
| 08 | GPIO GPIO is the acronym for ‘General Purpose Input/Output’, meaning that pins can be configured as input or output.  In your own words, describe why GPIO pins are configured as inputs by default within the hardware of a microprocessor/microcontroller.  Complete your answers in the A08 area on the following page. |
| A08 | GPIOWhy are the GPIO pins on IoT devices configured as inputs by default? (1 – 5 sentences) |
| 09 | GPIO, SPI, ADC/DAC and I2C Many IoT devices are run by “system on chip” (SOC) which provide a lot of interfacing capabilities.  Raspberry Pi provides a 26- or 40-pin header that provides the connectivity to some, or all, of these capabilities.  What is I2C, and why is I2C so useful for IoT?  What is SPI?  What does the term “multiplexing” mean, and how could it be useful in IoT?  Complete your answers in the A09 area on the following page. |
| A09 | GPIO, SPI, ADC/DAC and I2CWhat is I2C and why is it so useful in IoT? (2 – 8 sentences)What is SPI? (1 – 5 sentences)What is Multiplexing and how could it be useful in IoT? (1 – 5 sentences) |
| 10 | Simple Actuators In a second prototype, using an Arduino you are to activate a small water pump every 10 minutes for 15 seconds. The pump is rated at 4.5V and 0.18A. It can lift water up to 55cm above its base and requires at least 1V to start. It has a maximum flow rate of 100 litres/hour (l/h).  Answer the following questions:   1. What is the power use of the Pump when running at full capacity? 2. When using a GPIO on an Arduino, is the GPIO able to supply the required voltage and current to run the pump? 3. If the GPIO on the Arduino is not able to supply the required current and voltage, how could you modify the circuit to provide the pump’s requirements? 4. If you are running the Arduino Uno and the Pump together with the pump being on continuously, how long will a battery of capacity 20000mAh power the device from full capacity to zero? 5. You are running the Arduino Uno and the Pump together with Arduino on continuously and the pump being on for 15 seconds every hour. Presume that any additional circuitry does not affect the power requirements.  How long will a battery of capacity 20000mAh power the device from full capacity to zero? 6. Batteries (LiPo, NiCad and others) generally have a “low point” that stops them from providing power until they are totally flat. Likewise, they generally do not deliver their full rated capacity.   If the above 20000mAh battery “disconnects” and is unable to run the device at a capacity of 2500mAh and it may only provide 85% of the maximum capacity, how long will the Arduino and pump be able to be run before there is not enough power? Again, presume the additional circuitry does not affect the power requirements. |
| **A10** | Simple ActuatorsWhat is the power use of the Pump when running at full capacity?  * …  Is the Arduino able to supply the required voltage and current to the pump (yes or no)?  * …   *Presume the GPIO is not able to supply the voltage and current for the pump, how would you modify the circuit to be able to provide the needs of the actuator? (1-10 sentences, diagrams encouraged)* How long will a battery of capacity 20,000mAh power the Arduino Uno and Pump is they both are continuously on? (any additional circuitry that may be required may be ignored)Using the same battery, and other conditions, how long will the battery run the Arduino and pump if the Arduino is on continuously, but the pump is activated for 15 seconds every hour?How long will the 20,000mAh battery provide power to the Arduino and Pump “disconnects” at a capacity of 2500mAh and can only provide 85% of the maximum capacity, how long will the Arduino and pump be able to be run before there is not enough power? |
| END | Submission of Portfolio Work To submit the portfolio, do the following:   * Save this document with your answers as a MS Word file (.docx). * Export this document as a PDF file  (Windows: Use File Print Select printer: “Microsoft Print to PDF”). * DO NOT add the Word Document and PDF to a compressed file. * Open Blackboard and locate the AT2 Portfolio Task 1 assessment. * Open the assessment and upload the Microsoft Word and PDF documents. * Click submit.   Whilst there is no need to use any other word processing software as you have access to Office 365 for free as a student, if you use Apple Pages, or Open Office, we will then require you to upload the original file **AND** a PDF version. |

# appendix A: Terminology

|  |  |
| --- | --- |
| **Term** | **Definition** |
| **…** |  |
| **Camel Case** | First letter is lower case, every first letter of a new word is Upper case. No Spaces or other punctuation characters between words.  thisIsCamelCase |
| **Kebab Case** | Words are all lower case with dashes/minus signs (-) between words. No spaces or other punctuation characters between words.  this-is-kebab-case |
| **Lower case** | The anglophile small letters a through to z.  a, b, c, d, e, f, g, h, i, j, k, l, m, n, o, p, q, r, s, t, u, v, w, x, y, z |
| **Pascal Case** | Every first letter of a word is Upper case. No spaces or other punctuation characters between words.  ThisIsPascalCase |
| **RTFM** | Read The Flipping Manual |
| **Shouty Kebab Case** | Words are all upper case with dashes/minus signs (-) between words. No spaces or other punctuation characters between words.  THIS-IS-SHOUTY-KEBAB-CASE |
| **Shouty or Angry Snake Case** | Words are all capital letters with underscores (\_) between words. No spaces or other punctuation characters between words.  THIS\_IS\_SHOUTY\_SNAKE\_CASE |
| **Snake Case** | Words separated by an underscore (\_). No spaces or other punctuation characters between words.  this\_is\_snake\_case |
| **TBA** | To be advised |
| **TBD** | To be determined |
| **Upper Case** | The anglophile capital letters A through to Z.  A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V, W, X, Y, Z |
| **Number** | A numerical value using the digital 0 through to 9 and an optional single decimal point, with an optional minus sign (-) in the first position to indicate a negative number.  123.456  9876  0 |
| **…** | … |

# Appendix B: File Naming Conventions

The following are the naming conventions for code, folders and other documents unless otherwise contradicted by instructions in the assessment item.

## General Rules

Folders must be named using lower case letters, the numbers 0-9 and the dash/minus sign (-) ONLY.

No spaces to be used in any file or folder names at any time.

## PHP

Filenames to be in camel case, with .php at the end.

Stick to one convention, and do not change, unless the framework or similar dictates a different convention. See exceptions.

### Exceptions:

Files with classes must be Pascal Case.

Template files for blade and other engines will end with .blade.php or similar (engine dependant).

### Examples:

|  |  |
| --- | --- |
| Ordinary PHP file | this-is-a-php-code-file.php |
| File with Class definition | CarController.php |

## C/C++

Filenames to be in snake case ending in .c (source files) or .h (header files). See exceptions.

### Exceptions:

Arduino code files usually end in .ino (source) and .h (header).

### Examples:

|  |  |
| --- | --- |
| Ordinary PHP file | this-is-a-php-code-file.php |
| File with Class definition | CarController.php |

## HTML, CSS and JavaScript

Filenames to be in kebab case.

They will end with .html (HTML file), .css (CSS File) or .js (JavaScript file).

### Exceptions

Some HTML/CSS/JS frameworks have specialised extensions. Ensure you always follow the framework guidelines. Examples below.

|  |  |
| --- | --- |
| React | .jsx |
| SASS | .sass, .scss |

### Examples:

|  |  |
| --- | --- |
| HTML file | home.html |
| CSS File | Rest.css  site-styles.css |
| JavaScript File | app.js |

## Python

Filenames are to be in snake case ending in .py (source files). See exceptions.

### Exceptions:

TBD

### Examples:

|  |  |
| --- | --- |
| Ordinary PHP file | this-is-a-php-code-file.php |
| File with Class definition | CarController.php |

## C#

Filenames to be in snake case ending in .cs (source files) or .h (header files). See exceptions.

### Exceptions:

TBD

### Examples:

|  |  |
| --- | --- |
| Ordinary PHP file | this-is-a-php-code-file.php |
| File with Class definition | CarController.php |

# Appendix C: Code Style Guidelines

## C/C++/Arduino, C#

To be determined

## HTML/CSS/JS

To be determined

## PHP

To be determined

## Python

Your code will follow the PEP 8 standard.

Readability Counts  
- Zen of Python

Explicit is better than implicit.  
- Zen of Python

Other code standards available in the Presentation, “Python Coding Standards for North Metropolitan TAFE”.