**Course: Robotics & Mechatronics T**

**Unit: Digital & Analog Interactions**

**Unit Value: 1.0 Semester 2, 2020 Assessment Value:** XX%

**Assessment Item:** Project 1 **Teacher**: Mr C. Johnson

**Date Notified**: XXXXXXXX (Week XX)

Draft Due: XXXXXXXX (Week XX)

**Date Due:** XXXXXXXX (Week XX)

**TASK SUMMARY:**

Automated traffic lights are now a normal part of modern life. Interestingly, in South Africa traffic lights are called “robots” (apparently because they were first described as “robot policemen”). And in the Democratic Republic of the Congo, they actually use humanoid robots to control traffic in some locations. Traffic light control technology is increasingly advanced, as part of intelligent transportation systems. In this Project you will do some research into traffic light control, as well as design and create a simulation of one traffic light scenario within a transportation system.

This Project has three parts:

1. **Research traffic light technology**: Provide written responses as researched answers to provided questions.
2. **Traffic light simulation**: Design and create a traffic light scenario simulation (each student implementing a different agreed scenario), and submitting a written report documenting your solution, and also a short video as evidence of your working solution.
3. **Congo Traffic Robots**: Research and evaluate the humanoid traffic robots in the Democratic Republic of the Congo, submitting a brief written report.

No work submitted should be hand-written, including text, diagrams, equations, tables, graphs. “Camel case” should be used in any produced code for all variable and function names. Appropriate computer applications should be used to produce you work. As an exception, complex diagrams may be hand drawn if they are difficult to produce with a computer, but they should be scanned or photographed for insertion into your work.

**NOTE**: This assignment is to be your own individual work, and there should be no collaboration between students. You may consult with your teacher if you are uncertain about what is required.

*Drafts will not be accepted after the due date above. The draft is for general feedback only and will not be marked and graded, and marks will be based only on the final submission.*

**Submission Instructions:**

1. All work needs to be submitted electronically via Schoolbox by 1.15 pm on the day it is due, including a copy of the College Assessment Task Cover Sheet (including the Declaration of Original Work). **Problems with printing or associated computer/internet problems are not regarded as valid reasons for late submission of work.**
2. For clarification on BSSS Policies on penalties for late submission and plagiarism where work is completed out of class, students should refer to one or more of the following; Unit Outlines, the BCC Student Assessment Booklet, the BCC Year 11 and 12 Student Handbook, the BSSS publication, ‘What’s Plagiarism: How you can avoid it” and the BSSS Website <http://www.bsss.act.edu.au/The_Board/policy_and_procedures_manual>.

**TASK DETAILS:**

1. **Research traffic light technology**: Research answers to the following questions and submit written responses. For each answer include properly formatted references to the source(s) used.
   1. *[1 mark]* For one capital city (eg Canberra, Sydney, Brisbane, Melbourne, Hobart) identify the name of the intelligent traffic system used. (Each student will choose a different city.)
   2. *[9 marks]* For the intelligent traffic system used above, identify three beneficial functions of the system (other than coordination of flow, which is addressed below), also briefly explaining how each function is beneficial (25-50 words each).
   3. *[2 marks]* In traffic light cycles, what is “all red” time, and why is it important?
   4. *[3 marks]* Traffic signals can be coordinated, using a common signal cycle time and a calculated timing offset between the start of one intersection's main green movement and the next intersections main green movement. What is the main benefit of this mode? Also, briefly explain one disadvantage of using this coordination.
   5. *[5 marks]* Identify one kind of traffic sensor used in real life and give a 50-100 word explanation of how the technology works, including the science behind it, also identifying both advantages and limitations of the sensor.
   6. *[2 marks]* In 25-50 words explain how live data from the sensor above could be used to intelligently improve traffic control.
2. **Traffic light simulation**: You will design and construct a circuit controlled by a BBC micro:bit as a prototype to simulate an aspect of a traffic control system. In consultation with the teacher choose a scenario from the list below, or another option negotiated with the teacher. Each student must choose a different scenario. In each case traffic lights will be simulated by sets of green, yellow and red LEDs on a breadboard. If not otherwise specified, the traffic lights for cars in opposite directions on the same road show the same signals at the same time, with a green signal lasting a minimum of 50 seconds (which should always be observed), a yellow signal lasting four seconds, and the all-red time lasting three seconds.

Prepare the following documentation and submit it on Schoolbox for marking:

* 1. **Circuit Diagram & Photographic Evidence**: Provide a circuit schematic of the prototype you create, with clear labelling. Also include photographic evidence of the circuit you constructed.
  2. **Logic Design**: Provide a flow chart or other similar clear documentation showing the logic that will be following in the programming of your micro:bit to control the circuit.
  3. **Testing Procedure and Results**: Provide clear documentation showing how you will test that your simulation works correctly, also with a record of the results of your testing.
  4. **BBC micro:bit coding**: Provide a copy of your program code, including comments where explanation is helpful to the reader.
  5. **Video Evidence**: Create a short video showing your working solution, clearly demonstrating that all functionality works as expected.
  6. **Evaluation**: Write a self-evaluation of your simulation (both hardware and software), identifying and explaining any short-comings, and evaluating the impact of these short-comings. (Maximum 400 words)

1. **Congo Traffic Robots**: Research and evaluate the humanoid traffic robots created by Thérèse Izay Kirongozi in the Democratic Republic of the Congo. Submit a brief written report (500-700 words) which addresses the following aspects:
   1. What is the reason they were created, and what functionality do they provide?
   2. What improvements were made after the first iteration?
   3. Critically evaluate the benefits and disadvantages of this solution.

You will need to do some research to support your responses with evidence, using in-text referencing where appropriate, and a final list of references at the end, all properly formatted. As an appendix (not part of the word count), you should also include copies of any referenced pages, so your teacher can readily check your references. It is best if you compile this appendix as you use the sources and conduct your research, rather than trying to produce it after you have finished.

*Scenario Options for Traffic Light Simulation:*

1. **Four-way intersection with vehicle detectors**: The lights for cars in opposite directions on the same road show the same signals at the same time, with a cycling sequence that can be interrupted by detection of vehicles at the intersection. Use buttons, switches or “home-made” touch pads to simulate car detection sensors. If no vehicles are detected, the green signal will only last 50 seconds. If vehicles are travelling on one road (the busier road) and none on the other road, then the green light will stay on for a maximum of 3 minutes. On the other road the green light will stay on for a maximum of 90 seconds.
2. **T-junction with railway crossing:** Two railway lines (one for each direction) cross one of the roads just prior to the intersection. When a train comes in either direction, the traffic lights should prevent traffic from crossing the railway lines. Add additional red or green LEDs to simulate red or green arrow traffic lights, preventing or allowing traffic to turn into roads while the railway crossing is blocked. Also add an additional red LED that will flash on and off while the train is stopping traffic (in a real situation there would also be boom gates lowered, but you do not need to simulate this).
3. **Straight road with pedestrian crossing:** The traffic lights will only change when a pedestrian wants to cross the road. Use additional green LEDs to simulate the “WALK” signal, and red LEDs to simulate the “DON’T WALK” signal. The “WALK” signal should last 20 seconds, after which the “DON’T WALK” will flash for 10 seconds before staying on. Use buttons to simulate pedestrian push buttons. Also use an active buzzer with each button that beeps slowly when not allowed to cross and fast when the “WALK” signal is displayed.
4. **Coordinated flow across two intersections:** Simulate two four-way intersections (A and B), with a main road common to both intersections. During peak times (7:30am to 9:30am and 3:00pm to 6:00pm) the traffic flow between the two intersections is coordinated so that the green light phases start and end 20 seconds apart (in different directions for each peak time). During peak times, while traffic is flowing in the high volume direction on the main road, the green phase for the main road will stay on longer than the minimum time, to a maximum of 3 minutes. Flow detection can be simulated by simply having two detectors, one on each side of the main road, where traffic enters your intersections. Use buttons, switches or “home-made” touch pads to simulate car detection sensors. Outside of peak times the lights at both intersections will be synchronized, following minimum cycle times.
5. **Emergency vehicle exiting station on main road:** An emergency services station (fire/ambulance) is beside a main road. There are two sets of traffic lights for normal traffic (for each direction on the main road), which normally always stay on green. When emergency vehicles need to exit the station, they may turn either right or left. Use two switches to indicate whether an emergency vehicle is waiting to turn right (one switch) or left (the other switch). Both may be activated at the same time. When the right switch is activated, both traffic lights should immediately progress to red phase (with normal yellow phase first). When the left switch is activated, only the closest lane to the station should immediately progress to red phase. The traffic light(s) will change back to green after the switch has remained off for at least 3 seconds. There should also be two red LEDs for the station which should flash in an alternating patter as long as any switch is activated.
6. **Bus priority at four-way intersection**: The lights for cars in opposite directions on the same road show the same signals at the same time, with a cycling sequence that can be interrupted by detection of buses in a special bus-lane on one of the roads at the intersection. Use a button, switch or “home-made” touch pad to simulate a bus detection sensor. If no bus is detected, the green signals will last 75 seconds. If a bus is detected in the bus lane, the intersection will progress to “all red” phase, as long as the green phase has lasted the minimum time. After the normal “all red” time, use a blue LED to signal that the bus is allowed to pass through the intersection in any direction, keeping all other lights on red. The blue LED will stay on for a minimum of 10 seconds and will stop after no buses are detected for 3 seconds. The intersection will then enter a special “all red” phase lasting for 7 seconds, after which it will resume the previous intersection sequence.

**ASSIGNMENT MARKING SCHEME** (T Course – Total 80 Marks)

| **Item Assessed** | **A Grade**  (100% - 85% marks) | **B Grade**  (84% - 70% marks) | **C Grade**  (69% - 55% marks) | **D Grade**  (54% - 40% marks) | **E Grade**  (39% - 0% marks) | **Marks** |
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| Research traffic light technology: Answers to Questions | ▪ Able to answer all questions confidently, accurately, concisely and coherently, with full understanding and using appropriate terminology  ▪ All answers include relevant referencing, with all required information, and all appropriately formatted | ▪ Able to answer most questions confidently, accurately, and coherently, with clear understanding and using appropriate terminology  ▪ Most answers include relevant referencing, with all required information, and all appropriately formatted | ▪ Able to answer most questions accurately and coherently, with some appropriate terminology  ▪ Some answers include relevant referencing, with all required information, and mostly appropriately formatted | ▪ Able to answer some questions with some accuracy and coherency, with some appropriate terminology  ▪ Some relevant referencing is included for some answers | ▪ Able to answer a few questions with accuracy and coherency  ▪ Some referencing is included | /22 |
| Traffic Light Simulation: Circuit Diagram & Photographic Evidence | ▪ Circuit design is functional with all required features and components, with no redundancy  ▪ Includes clear photographic evidence of circuit implementation | ▪ Circuit design is functional with most required features and components, perhaps with some redundancy  ▪ Includes clear photographic evidence of circuit implementation | ▪ Circuit design demonstrates significant functionality, mostly incorporating required major features and components  ▪ Includes photographic evidence of circuit implementation | ▪ Circuit design demonstrates some significant functionality, incorporating some required major features and components  ▪ Includes photographic evidence of circuit implementation | ▪ Circuit design demonstrates some functionality, incorporating some required features and components | /10 |
| Traffic Light Simulation:  Logic Design | ▪ Logic design is functional incorporating all requirements, with no redundancy or mistakes, represented clearly and correctly with flowcharting or other appropriate means | ▪ Logic design is functional incorporating most requirements, perhaps with some redundancy or mistakes, represented clearly with flowcharting or other appropriate means | ▪ Logic design demonstrates significant functionality, mostly incorporating major requirements, represented effectively with flowcharting or other appropriate means | ▪ Logic design demonstrates some significant functionality, incorporating some major requirements, represented with flowcharting or other appropriate means | ▪ Logic design demonstrates some functionality, incorporating some requirements, represented with flowcharting or other means | /7 |
| Traffic Light Simulation:  Testing Procedure and Results | ▪ Procedure is thorough and clear, comprehensively and effectively testing all required features and components  ▪ Results for all tests are clearly recorded | ▪ Procedure is clear, effectively testing most required features and components  ▪ Results for most tests are clearly recorded | ▪ Procedure effectively tests most required major features and components  ▪ Results for most tests are recorded | ▪ Procedure effectively tests some required major features and components  ▪ Results for some tests are recorded | ▪ Procedure tests some required features and components  ▪ Results for some tests are recorded | /7 |
| Traffic Light Simulation:  BBC micro:bit Coding | ▪ Implemented code is functional and high-quality, without errors and implementing all required features, demonstrating confident skills and understanding even with complex concepts  ▪ Comments are concise and clear, making the code more readable  ▪ Camel case is always used where appropriate | ▪ Implemented code is functional, mostly without errors and implementing most required features, demonstrating competent skills and understanding with some complex concepts  ▪ Comments are helpful, mostly making the code more readable | ▪ Successfully implemented most non-complex features, demonstrating competent skills and understanding with non-complex concepts, and able to significantly attempt more complex programming  ▪ Some helpful comments are included | ▪ Significant attempts to implement most non-complex features, demonstrating some skills and understanding with non-complex concepts  ▪ Some comments are included | ▪ Some attempt to implement non-complex features, demonstrating some skills with non-complex concepts  ▪ No comments are included | /7 |
| Traffic Light Simulation: Evaluation | ▪ Critically analyses the solution evaluating its appropriateness and effectiveness and explaining any weaknesses, evaluating the impact of any short-comings  ▪ Mostly uses appropriate terminology with full understanding | ▪ Analyses the implemented solution evaluating its appropriateness and effectiveness and describing any weaknesses, explaining the impact of any short-comings  ▪ Generally uses appropriate terminology with understanding | ▪ Explains the implemented solution evaluating its appropriateness and effectiveness and identifying any weaknesses, describing the impact of any short-comings | ▪ Describes the implemented solution evaluating its appropriateness and effectiveness and identifying any weaknesses, identifying the impact of any short-comings | ▪ Identifies the implemented solution with little or no reference to its appropriateness and effectiveness, and without identifying any weaknesses | /6 |
| Traffic Light Simulation:  Video Evidence | ▪ Includes video evidence, demonstrating that all features work as expected | ▪ Includes video evidence, demonstrating that most features work as expected | ▪ Includes video evidence, demonstrating some of the features working as expected | ▪ Includes video evidence, demonstrating some of the actual implementation | ▪ Does not include video evidence | /3 |
| Congo Traffic Robots:  Content | ▪ Shows a confident and in-depth understanding of the motivation behind the design and also the functionality provided  ▪ Identifies and explains differences in significant iterations of the design  ▪ Shows outstanding integration and synthesis from a range of sources and perspectives  ▪ Achieves an insightful and convincing evaluation which resolves complexity or conflict in the sources  ▪ Demonstrates strong ability to analyse relevant social, historical or cultural effects | ▪ Shows some in-depth understanding of the motivation behind the design and also the functionality provided  ▪ Identifies differences in significant iterations of the design  ▪ Successfully integrates and synthesises from a range of sources and perspectives  ▪ Achieves a clear and convincing evaluation showing some awareness of complexity or conflict in the sources  ▪ Demonstrates some ability to analyse relevant social, historical or cultural effects | ▪ Shows a broad and general understanding of the motivation behind the design and also the functionality provided  ▪ Adequately integrates ideas from a range of sources  ▪ Constructs an evaluation based on simple analysis of sources  ▪ Demonstrates some ability to identify relevant social, historical or cultural effects | ▪ Shows some understanding of the motivation behind the design and also the functionality provided  ▪ Refers to obvious sources  ▪ Shows limited insight or perspective  ▪ Constructs a descriptive narrative  ▪ Has limited recognition of relevant social, historical or cultural effects | ▪ Shows limited understanding of the motivation behind the design and also the functionality provided  ▪ Constructs a descriptive narrative | /10 |
| Congo Traffic Robots: Referencing | ▪ Always uses inline referencing where substantiation is needed, with an appropriately formatted list of references  ▪ Use of references demonstrate fluency in understanding relevant literature, and a consistent ability to deeply understand, evaluate and apply ideas of others  ▪ Referenced sources are always credible and of academic quality and relevant  ▪ Copies of referenced sources is included as an appendix | ▪ Sometimes uses inline referencing appropriately, with an appropriately formatted list of references  ▪ Use of references demonstrate competency in understanding relevant literature, and some ability to understand, evaluate and apply ideas of others  ▪ Some sources are of academic quality, and most sources are credible and relevant  ▪ Copies of referenced sources is included as an appendix | ▪ A list of references generally appropriately formatted  ▪ Use of references demonstrate some understanding of and some ability to interact with the ideas of others  ▪ Referenced sources usually have some relevance and some credibility  ▪ Copies of referenced sources is included as an appendix | ▪ Some references are included, having some relevance and credibility | ▪ No references are included, or no references have any relevance or credibility | /3 |
| Congo Traffic Robots: Communication | ▪ Consistently communicates clearly, concisely, accurately and coherently with vitality, maturity of expression and a confident and distinctive voice  ▪ Demonstrates strong sense of direction and purpose; paragraphs linked; outstanding introduction and conclusion  ▪ All paragraphs are well-constructed, with very few or no grammatical or spelling errors  ▪ Always uses technical terminology appropriately and correctly | ▪ Generally communicates clearly, logically and accurately with maturity of expression and a confident voice  ▪ Demonstrates clear sense of direction and purpose; paragraphs linked; effective introduction and conclusion  ▪ Most paragraphs are well-constructed, with few grammatical or spelling errors  ▪ Mostly uses technical terminology appropriately and correctly | ▪ Generally communicates clearly  ▪ Demonstrates sense of direction and purpose; paragraphs linked; introduction and conclusion linked to question  ▪ Paragraphs are generally satisfactorily-constructed, with some significant grammatical or spelling errors  ▪ Often uses technical terminology inappropriately and/or incorrectly | ▪ Often communicates without clarity  ▪ Demonstrates partial grasp of essay structure  ▪ Paragraphs are generally poorly-constructed, with many grammatical and spelling errors  ▪ Occasionally uses technical terminology appropriately and/or correctly | ▪ Consistently communicates without clarity  ▪ Experiences difficulty with essay structure  ▪ Paragraphs are generally poorly-constructed, with many grammatical and spelling errors  ▪ Never uses technical terminology appropriately and/or correctly | /5 |
| **TOTAL MARK** | | | | | | **/80** |