Sample Assignment Brief

AQA Level 3 Technical Level Engineering: Mechatronic Engineering
Mechatronic Control Systems

Tutor/Assessor name			
Assignment Title			
Date assignment issued		**Submission Date**	

Task number	**Grading criteria to be evidenced in the task**
Task 1	P1, P2, P3
Task 2	P4, M1, M2, D1
Task 3	P5, P6, P8, P9, P10
Task 4	P7, P11, M4, M6, M7
Task 5	M3, M5, D2, D3

Learner Authentication

I confirm that the work and/or the evidence I have submitted for this assignment is my own. I have referenced any sources in my evidence (such as websites, text books). I understand that if I don't do this, it will be considered as a deliberate deception and action will be taken.

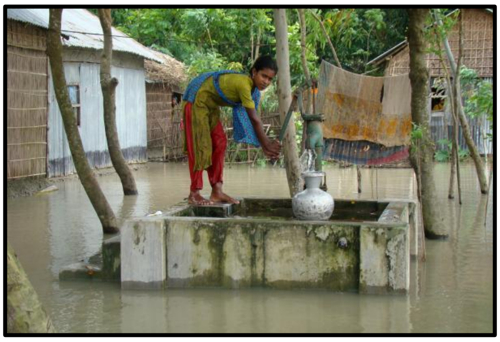
Learner Signature **Date**

Tutor/Assessor Signature **Date**

WHO IS PRACTICAL ACTION?

Practical Action is an international non-governmental organisation (NGO) that uses technology to challenge poverty in developing countries. It works with local communities to find practical solutions to the problems that they face. It primarily focuses on areas such as energy access, food and agriculture, urban waste, and water and disaster risk reduction. The organisation currently has over 100 projects in progress worldwide. In 2014 it used technology to directly benefit over 1.2 million poor women and men through projects in developing countries around the world.

Many of the projects undertaken by Practical Action involve engineering activities. For example, to reduce the risk of disasters for marginalised groups and communities, projects have included the use of rain-harvesting technologies to reduce the impact of drought, the redesign of flood and earthquake resistant housing, flood warning systems and the preparation of methods to survive freak and extreme weather conditions, such as freezes.
The design of cluster villages in Bangladesh built on six-feet-high plinths means that housing is not doomed to be washed away during extreme monsoon and flood conditions.



Water pump built on a raised plinth

Community learning about early warning flood systems

Various engineering technologies can be applied to reduce the effects of flooding in remote, rural parts of the world. In June 2013 the Karniali River in the Bardiya district of Nepal burst its banks due to incessant rainfall. A number of local villages were placed at risk of flooding. As the river began to swell villagers were kept updated by a telemetric system and display board that relayed information every 15 minutes. Once the water level of the river became dangerous, the authorities were able to put together an evacuation plan including the army, police force and the Red Cross. Sirens, microphones, jackets and boats were also provided as part of the project. This use of flood warning technology undoubtedly prevented loss of life.

TASK OVERVIEW

Within this assignment you will research, design, build and test a mechatronic system that will act as a flood warning and prevention system. The system must be able to detect rising water levels, warn people of this and close a barrier to prevent flooding from occurring. The system design must consist of both **electronic** and **pneumatic** elements and utilise electronic control systems with either Programmable Logic Controllers (PLC) or microcontroller components.

You must also show an understanding of the characteristics of different control systems, and evaluate the benefits and drawbacks of these with reference to your own final design.

Encased stone flood defence barrier in Nepal

FLOOD PREVENTION SYSTEM DESIGN

Task 1: PO1 – Research common control system characteristics (P1, P2, P3)

The first stage of the process is to become fully familiarised with mechatronic systems, the principles of control theory and the different types of sensors contained within a mechatronic system. This will also help you when developing your own mechatronic system.

You should carry out an examination of the components and functions of the identified mechatronic systems and produce a report of your findings. This should include **sketches or diagrams** for all parts and written commentaries of their operations. The report should include:

- The identification of three mechatronic systems containing multiple sensors, control systems and actuators. These should be clearly described, and the features that make them mechatronic should be acknowledged (P1).
- An expanded explanation of the principles of control theory on one of your selected mechatronic systems (including open and closed feedback loops, subsystems and the principles of the input and output process). This should be in the form of an annotated diagram (P2).
- The identification of a common control system with multiple sensors. From this control system, three different types of sensor should be selected and their operations described (P3).

Task 2: PO1 – Identifying the flow of signals through a mechatronic system (P4, M1, M2, D1)

The next step in developing your knowledge of mechatronic systems is to demonstrate your awareness of the flow of signals through the components of a system, and the variation of signal progression when affected by variable conditions.

Using **sketches, diagrams and flow charts** with written explanations, identify a common mechatronic system and describe the flow of signals through it. In doing so, you should:

- Identify the way in which signals pass through the system in different modes, the components involved and the effect of different conditions on the signal (P4).
- Describe the process by which input into a sensor results in a change in output from an actuator in a specified component, and explain how the input signal is modified and used to change the actions of two different actuators (M1).
- Describe in detail the signal conditioning element of the control system, and explain what happens as the signal passes through the controller (M2).
- Identify two key control system components within the mechatronic system and justify why these have been selected for use, and consider whether other components could have been utilised instead (D1).

Task 3: PO2/PO3 – Designing a mechatronic system (P5, P6, P8, P9, and P10)

Create a design to construct a suitable mechatronic system for a flood prevention system. This should include an electronic control system and a pneumatic system to operate the barrier (as the barrier may be in contact with water, there would be safety concerns if this was operated electrically).

Using suitable **sketches, drawings, diagrams or photographs**, create your design. This should identify the inputs, processes, outputs and signals that operate within the electronic control system, along with any feedback loop (P5 and P8). Include a separate description of the measurement, control and actuation of the pneumatic elements involved.

In addition, you should show clearly how PLCs and microcontrollers are integrated into electrical control systems, and describe the function of the PLC or microcontroller within your system design (P10).

Your design must take into account the characteristics required of a flood warning and prevention system. The system must be able to detect, through the use of suitable input sensors, the level of the water. It must use a suitable output device to inform people when the water level is reaching a dangerous level, and/or indicate the current level of the water. When the water reaches levels that could potentially lead to flooding, the pneumatic system should raise a barrier vertically by 90° to prevent floodwater from getting past. Once the danger of flooding has passed the input sensors should detect this and the barrier should be lowered back to its original position.

You must consider all of the following (P6 and P9):

- How the flood prevention system will be triggered – what are the most appropriate input sensors to use?
- How the system will inform potential flood victims that water levels have reached a dangerous level – what are the most appropriate electronic output devices to use?
- How the pneumatic system will raise and lower the flood barrier when potential flooding has been detected.
- Which electronic and pneumatic components to use, taking into account cost, functionality and practicality.
- How the system will be programmed to achieve the desired outcomes.

You should describe the control and output actions of the pneumatic components of the system, and use a systems block diagram to describe the electrical components in the control system that you have designed. Your design should include a suitable PLC or microcontroller, and you should describe the function of this within your planned system.

Task 4: PO2/PO3 – Building a mechatronic system (P7, P11, M4, M6, AND M7)

Next, you should construct the control system you have designed using various suitable methods, working in a safe manner at all times (P7 and P11).

You should show a clear step-by-step record of the process taken, using **video or photographic evidence** if appropriate.

In addition to constructing your control system, you should explain how the components you have chosen interact (M4 and M6). This should include explanations of how different pneumatic components work together and of how different electrical components operate together with the PLC or microcontroller (M7).

You should clearly demonstrate the interdependence of components, and explain how the choice of PLC or microcontroller in the design has affected the selection of other components, for example, the necessity to use diodes to protect against the risk of back emf, or the need for resistors to limit current.

Task 5: PO2/PO3 – Testing a completed mechatronic system (M3, M5, D2, D3)

After construction of your mechatronic control system you should perform a series of appropriate tests to ensure it functions correctly (M3 and M5). You must record the results of the tests in an appropriate format to ensure they can be easily interpreted. For example, this could be presented in a **table**. Individual tests should be performed on both the pneumatic components and the electrical components, and function tests should be made on the completed system.

Having obtained results from suitable testing, it is important that you analyse your findings to evaluate the success of your design and construction, and to pinpoint improvements that could be made to the control system (D2).

You should consider the control system holistically to suggest specific improvements and justify these logically, based on the results of your testing. In addition, you should fully evaluate the control system you have constructed, covering how well the system meets the given brief and how testing supported any improvements made (D3).

This evaluation should consider component selection, construction, performance, ease of maintenance and how well the system performs the specified operations. The correct size and operation of components, expected life of components and cost of maintenance should all feature in the evaluation. You could produce your evaluation in the form of a **report**, which could include suitable **diagrams and charts**.

Submission Checklist (please insert the items that the learner should hand in)	**Confirm submission**
Learner – please confirm that you have proofread your submission	

ADDITIONAL NOTES FOR TEACHERS

The intended outcome is a mechatronic system with integrated pneumatic and electronic systems. This should include appropriate input sensors to detect the level of the water. It should also include an output device capable of warning people that the water level is too high, or indicating the current level of the water. Additionally, it should include appropriate pneumatic systems to operate a barrier. This barrier should close, or rise, when the water has reached a dangerous level. Both the pneumatic and electronic systems should be completely integrated. The pneumatic system should respond to signals received from the electronic system.

Learners may wish to initially approach the design of the pneumatic and electronic systems separately, and then integrate the two at a later development stage, modifying their designs as necessary. Alternatively, they may wish to create their initial designs with integration of both systems from the very early stages of the assignment.

The following web links provide useful technical information and additional context for this assessment:

Case studies and impact of flood warning technology

http://practicalaction.org/who-is-most-at-risk-1

http://practicalaction.org/blog/where-we-work/nepal/early-warning-system-saves-lives-in-monsoon-hit-nepal/

http://practicalaction.org/climatechange_nepalfloods

http://practicalaction.org/flood-early-warning

http://practicalaction.org/flood-resistant-housing-drr

Thames Barrier flood prevention system: an existing flood prevention system that may act as a useful case study for learners.

https://en.wikipedia.org/wiki/Thames_Barrier

http://www.visitlondon.com/things-to-do/place/26941-thames-barrier-information-centre

http://www.bbc.co.uk/news/magazine-26133660

https://www.youtube.com/watch?v=GricS4iCgtc

https://www.youtube.com/watch?v=Dvg2asACsG0