

LEVEL 4 ASSESSMENT SPECIFICATION

Student name:	Shay Pallas	Student ID number:	
Programme:	HNC Electrical/Electronic Engineering, Power Systems Engineering & Instrumentation Engineering		
Module:	Industrial Measuring Systems		
Module code:	PCEE4003	Contribution to Overall Module Assessment (%):	100%
Lecturer:	Adam Jenkins	Internal Verifier:	Jason Pointer
Assignment Title:	Measurement Systems	Word count (or equivalent):	2000
Submission deadline:	15/05/20	Return date of provisional marks & written feedback:	29/05/2020
Submission method:	All written assessments, where practical and possible, must be submitted via Turnitin unless otherwise instructed by the Lecturer. (Please DO NOT put this assessment specification into Turnitin or it will match many similarities with other students' submissions.) Alternative submission method (if applicable): Late submission of the assessment will result in a late penalty mark. Penalties for late submission: Up to one week late, maximum mark of 40%. Over one week late, 0%. Only the Extenuating Circumstances Panel may approve a change to submission dates.		
Academic honesty / referencing:	Academic honesty is required. In the main body of your submission you must give credit to authors on whose research and ideas your work is based. Append to your submission a reference list that indicates the books, articles, etc. that you have used, cited or quoted in order to complete this assessment.		

Module Learning Outcomes (from module syllabus)

LO1, LO2.

STUDENT FEEDBACK FORM

This section details the *extent* to which the assessment criteria are demonstrated by you, which in turn determines your mark. The marks available for each category of skill are shown. Lecturers will use the space provided to comment on the achievement of the task(s), including those areas in which you have performed well and areas that would benefit from development/improvement.

Generic Assessment Criteria	Marks available	Marks awarded
1. Engagement with Literature Skills	20	6.6
Poor engagement with essential reading. No evidence of wider reading. Reliance on inappropriate sources.		
2. Knowledge and Understanding Skills	30	16
Task 1 achieved 70%. Task 2 achieved 66%. Task 4 achieved 50%. Task 5 achieved 35%. Task 6 achieved 45%. Knowledge of the basic underlying concepts and principles is accurate with a good understanding for most of the tasks but there is lacks depth in some areas. Did not cover all the requirements of Task 5 - Signal Transmission. Task 6 had a lack of detail.		
3. Cognitive and Intellectual Skills	10	4.5
Limited attempt at evaluation of the underlying concepts and principles, tending towards description.		
4. Practical Application Skills	30	22.5
Very good approach to developing the calculations to obtain the relative solution for task 3 but need to make sure that all formulas as shown. Excellent use of spreadsheets to obtain a range of solutions and to present these results.		
5. Transferable Skills for Life and Professional Practice	10	5
Mostly ordered presentation and structure but in places does lack some coherence. Some of your sentences are poorly constructed.		

Assessment Mark (Assessment marks are subject to ratification at the Exam Board. These comments and marks are to give feedback on module work and are for guidance only until they are confirmed.)	Late Submission Penalties (tick if appropriate)		55%
	Up to 1 week late (40% Max)		
	Over 1 week late (0%)		

Module Name: Industrial Measurement Systems

Module Code: PCEE4003

Course Name: HNC Electrical and Electronic Engineering

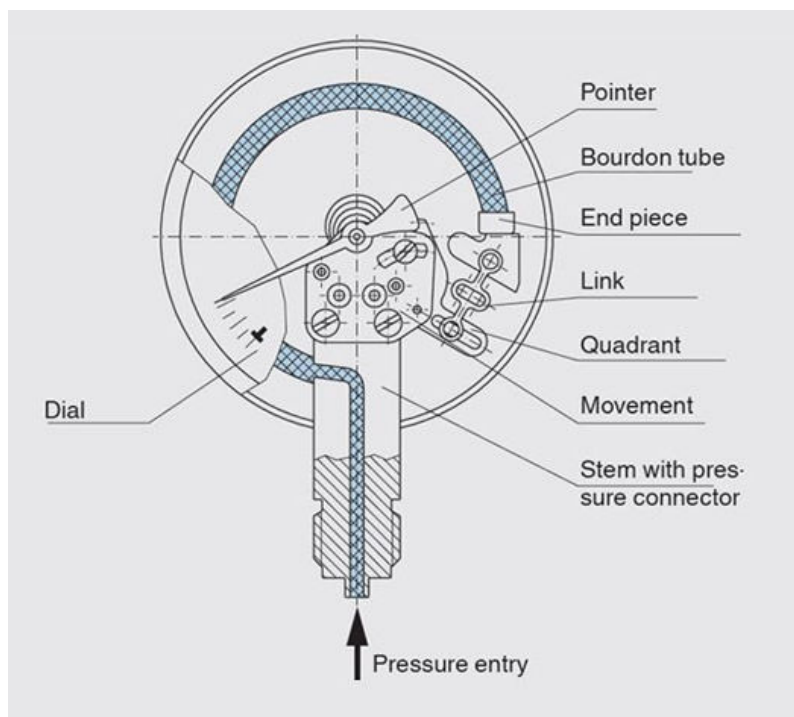
Student Name: Shay Pallas

Contents Page

1.0	Task 1	Error! Bookmark not defined.
2.0	Task 2	Error! Bookmark not defined.
3.0	Task 3	Error! Bookmark not defined.
4.0	Task 4	Error! Bookmark not defined.
5.0	Task 5	Error! Bookmark not defined.
6.0	Task 6	Error! Bookmark not defined.
7.0	Reference	Error! Bookmark not defined.
8.0	Bibliography	Error! Bookmark not defined.
9.0	Appendix	Error! Bookmark not defined.

1.0 Task 1

Whilst looking at the bourdon tube pressure gauge they are the most used pressure gauges. These types of pressure gauges have an accurate measurement through various testing in the construction stage. They are highly used due to them being extremely durable with a long-life expectancy. Bourdon tube pressure gauges have various types of measurement values. These pressure gauges are also affordable and minimal in cost compared to other pressure measurement methods. The construction behind the bourdon tube pressure gauge is a C shaped metal tube which is attached to mechanical components to move/rotate the pointer. When the pressure is applied to the bourdon tube it will begin to construct applying pressure to the mechanical components. This causes the pointer to move displaying the reading of the pressure on the scale. "The Bourdon pressure gauge uses the principle that a flattened tube tends to straighten or regain its circular form in cross-section when pressurized." (Instrument tools. 2020 [2]).



(Figure 1.)

<https://hikirbycorp.com/topic/bourdontubedef>

Whilst looking at digital pressure gauges there are many attributes which surround this piece of equipment. Whilst looking at the advantages of a digital pressure gauge one of the largest ones was the accuracy of the measurements and how clear the displayed results are. When using a digital pressure gauge, they're more suitable for reading variable pressures as there is options to change the valued reading, either increasing or decreasing the value readings. Very suitable for high vibration areas and well equipped for varying temperature areas. The working behind a digital strain gauge is measuring the resistivity of a metallic material and when the diaphragm varies from the pressure is applied. When the change in resistance is measured it will be converted into an electrical signal proportional to the pressure. See figure 2 for an example of a digital pressure gauge.



(Figure 2)

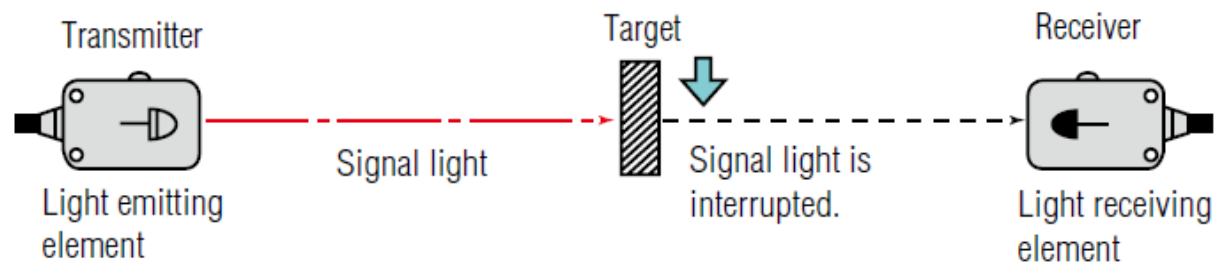
<http://www.ashfordvalves.com/pressureSwitches.aspx?AspxAutoDetectCookieSupport=1>

Whilst looking at information for the two different types of measuring devices they have different advantages which gets them both to be used in different scenarios. Whilst comparing the two pressure gauges there are different positives to both, the analogue bourdon pressure gauge is a more commonly used method due to the cost of construction with accurate measurements they're a reliable measuring solution. The digital pressure gauges are the superior one of the measurements as they are more accurate and better equipped for high risk areas. They're also extremely accurate. Due to the large price margin they are not the most used options.

2.0 Task 2

a) Identify a sensor that could be used to measure the angular velocity of an electric motor from 0 to 1800 RPM.

A photoelectric proximity sensor can measure this rate of RPM. The photoelectric proximity sensor can process the amount of RPM which is being produced by having a beam of light emitted from it. There will also be a light receiving element at the other side. In between the light emitting and light receiving element there will be a material blocking the light beam with a break in that material which will enable the light beam to pass through it. For the split second the light beam passed through and the light receiver receives the beam this will be labelled as a pulse. The photoelectric proximity sensor will calculate the amount of pulses which it receives and convert them into the RPM rating. See figure 3 for an example of a photoelectric proximity sensor. Photoelectric proximity sensor is a highly accurate measurement method for RPM. See appendix 1 for a data sheet which can be found at RS components.



(Figure 3.) <https://www.keyence.com/ss/products/sensor/sensorbasics/photoelectric/info/>



b) Identify a sensor that could be used to measure the rotation of a 3-way ball valve actuator through 180° operation. In addition, there is a requirement to indicate the operation of the valve from 0 to 100 % of its travel in both the forward and reverse action.

A variable resistor can be used to measure the positioning of the 3-way ball valve. The way this is functional is on installation of the variable resistor the position which installed will have a **current** reading which can be converted to voltage which can be set to position 1. This can determine the rest of the positioning of the 3-way ball valve. As when the position of the valve is moved the variable resistor's current will differ which can then be converted into a voltage which will output a different result establishing the new location of the 3-way ball valve. This method can also be used from a remote location. This form of measurement is viable for all positioning of the 3-way ball valve. See Appendix 2 for datasheet.



3.0 Task 3

a) Calculate the resistance of the sensor at 5°C intervals from 0 °C to 100 °C. You may use a table to collate your results but include all calculations in your answer.

$$R_{uf} = 100\Omega$$

$$T_{uf} = 0^\circ\text{C}$$

$$\alpha = 3.85 \times 10^{-3}$$

Temperature (°C)	Resistance (Ω)	VO
0	100	5
5	101.925	5.0477
10	103.85	5.0944
15	105.775	5.1403
20	107.7	5.1854
25	109.625	5.2296
30	111.55	5.2730
35	113.475	5.3156
40	115.4	5.3575
45	117.325	5.3986
50	119.25	5.4390
55	121.175	5.4787
60	123.1	5.5177
65	125.025	5.5560
70	126.95	5.5937
75	128.875	5.6308
80	130.8	5.6672
85	132.725	5.7031
90	134.65	5.7383
95	136.575	5.7730
100	138.5	5.8071

$$3.85 \times 10^{-3} - 100\Omega \text{ at } 0^\circ\text{C}$$

$$R_{uf} = 100$$

$$\phi = 3.85 \times 10^{-3} = 0.00385$$

$$T_{uf} = 0$$

$$T_m = 0^\circ\text{C to } 100^\circ\text{C}$$

$$R_t = R_{uf} (1 + \phi (T_m - T_{uf})) \quad \checkmark$$

- Apply for 10°C

$$R_t = 100 \times (1 + 0.00385(10^\circ\text{C} - 0))$$

$$R_t = 103.85\Omega \quad \checkmark$$

b) The platinum RTD is to be used in a voltage divider circuit (Fig 3.1 – Voltage Divider). If the supply voltage (V_s) is 10V, $R = 100\ \Omega$ and R_t is the platinum RTD calculate the circuit output for the same range of temperatures in question 1a. You may add a separate column to your table to show these results but include all calculations in your report.

$$V_o = \frac{V_{in} \times R_t}{R + R_t} \quad \checkmark$$

$$V_o = \frac{10V \times 103.85}{100 + 103.85}$$

$$V_o = 5.094V \quad \checkmark$$

c) Assuming the input and output responses of the sensor are linear, determine the sensitivity of the circuit.

$$\frac{\Delta \theta_o}{\Delta \theta_i} = \frac{5.8071 - 5}{100^\circ C} = 0.008071279V/^\circ C \quad \checkmark$$



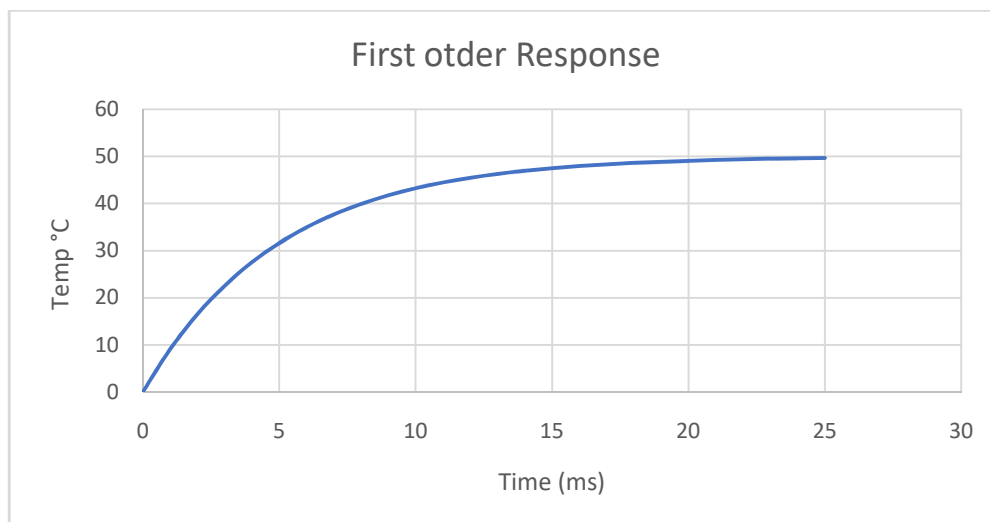
d) The temperature sensor has a first order response with a time constant of 5ms. Plot the output response to a step change in input from 0 °C to 50 °C in 1ms steps until a steady state condition is achieved.

Time (ms)	Temp (°C)
0	0
1	9.063462346
2	16.4839977
3	22.5594182
4	27.53355179
5	31.60602794
6	34.9402894
7	37.6701518
8	39.9051741
9	41.73505559
10	43.23323584
11	44.45984208
12	45.46410234
13	46.28632109
14	46.95949687
15	47.51064658
16	47.9618898
17	48.3313365
18	48.63381388
19	48.88146141
20	49.08421806
21	49.25022116
22	49.386133
23	49.49740821
24	49.58851265
25	49.66310265



Example of the calculation

$$T_m = T_{\infty} = 50 \times (1 - e^{-\frac{t}{\tau}}) = 9.064$$



4.0 Task 4

A) LED's are used most when working with seven segment displays as they use a very low power voltage and low current with a low costing effect. Another attribute to LEDs is the variability in which colours can be used. An important "attribute of a lighting source is its ability to faithfully render the colors of non-white objects that it illuminates." (OIDA, NEMA and DOE-BTS, March 2001.[1]) LED displays have more variability in the outputs which can occur from displays and have the option to add more segments to enhance the accuracy of the display. LED's produce their own source of lighting unlike LCDs which do not. LCDs use a reflected light. Once an electric flow is applied to the crystal it the reflective light which is produced will then appear dark. There are many advantages to using an LED seven segment display as they are very low in cost with high efficiency and minimal issues so are highly reliable for a low cost. LEDs work from a four input BCD chip which is a simplistic chip which converts the 4 inputs into seven binary values. Controlling the 7 segment inputs with ease. The limitation of an LED seven segment unit is the fact it has limited output. Which isn't caused from the LEDs itself other than the chip which is controlling the lighting display as it is limited to the 7 binary signals to display the output. LCDs are reliable sources of seven segment displays but aren't as highly used as LEDs as they take more voltage and current input with less variability over the control of the lighting. LCDs are efficient and reliable as there is minimal component control which has less risk to developing faults in the hardware.



B) Operation of an analogue to digital converter is to receive an analogue input and create a digital signal for a system which can then receive the digital information to supply an output. Many of analogue to digital converters have a programmable range which can vary the current range. One of the possible ways of doing this is through current loop D/A converters. View appendix 3 for a data sheet. Quantization within an ADC circuit is the replacement of the analogue value number with a digital signal. With the example which has been chosen has fixed points across the 16-bit resolution. The quantization error which can be found in ADCs are rounding errors which are introduced when converting the analogue value into a digital signal.



5.0 Task 5

- Conversion is used in measurement systems in various ways. One of the ways it is used is by taking a value such as a current on a variable resistor and converting the output into a voltage which can then be converted into a measurement. An example of this is the three-way ball valve measurement system in task 2 section b.
- Amplification is used to increase the power/output of a signal transmission. Whilst using an amplification method the input will be the signal which is being transmitted to the input terminals of the amplifier. Which will then produce a greater/amplified signal as its output. Amplifiers are used to increase value but simultaneously keep other factors of the wave the same, such as frequency.

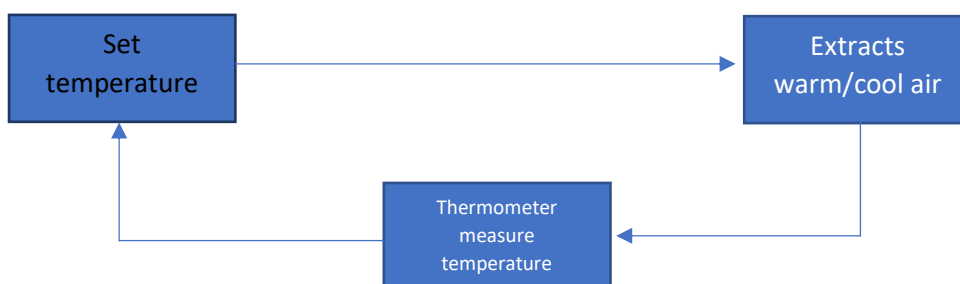


- With working with elimination is used to produce the most reliable, efficient, and effective results as possible. To determine the most efficient wave form to be used there must be minimum interference causing the elimination process to produce the best transmittal for the measurement system. "Based on the evaluation of the measured parameters and waveforms of signals, measures are suggested to eliminate the electromagnetic interference for reliable operation of control systems." (Z. Machacek [3]) ✓
- Signals can be manipulated within a process to produces specific outcomes depending on the process. To enable variation in outputs signals and limits must be able to be manipulated to produce a fluctuation in results. Control equipment must be able to fluctuate in process as variables may change. For example, a flow rate may need to change due to system error/bypass. Manipulation of the control signals to the instrument to allow higher flow rate to produce a different outcome. ✓
- Protection from over current damaging equipment, surge in voltage, external earthing can all cause damage to systems. Whilst transferring electricity from distribution boards/panels to component systems. Equipment like MCBs, MCCBs, relays and fuses are used to protect conversion and control devices. Minimising the risk of damaging equipment and components from over current. ✓

6.0 Task 6



- A) An open loop circuit is a circuit with an input with a variable aspect with an output. The input will be a switch, button, start stop button et. These are used as there is no measurable aspect which is in this circuit enabling a single input. A main example of an open loop is a light switch circuit. As this is a single input (switch) ones pressed, there will be a variable aspect (Electricity) will transport to the light and there will be a single output (Light). There is no measurement aspect within this which is causing it to be an open loop. ✓ 
- B) A closed loop circuit is a circuit which has a control element within it. a varying output which can change within the circuit. The control element can be a measurement variable which will vary the output depending on the scenario. For an example of a closed loop circuit is an aircon system. The temperature will be set to a constant amount and depending on the temperature (Control element) it will either extract warm air if the room is colder than the set temperature or extract cool temperature if the temperature is higher than the set temperature. A thermometer is the variable/measurement within the circuit. ✓



7.0 Reference

[1] -Jeff Y. Tsao, Sandia National Laboratories, November 2002, Light Emitting Diodes (LEDs) for General Illumination, OIDA, NEMA and DOE-BTS, Washington DC. Page 8. [Accessed 13 April 2020].

[2] - Instrumentation Tools. 2020. Working Principle of Pressure Gauge Instrumentation Tools. [ONLINE] Available at: <https://instrumentationtools.com/working-principle-pressure-gauge/>. [Accessed 16 April 2020].

[3] - Measurements and Elimination of the Electromagnetic Interference in Industry Environments. Z. Machacek, R. Hajovsky, J. Vanus and J. Koziorek. VSB TUO, Czech Republic. 2017. [Accessed 21 April 2020]

8.0 Bibliography

<https://www.electronicshub.org/seven-segment-displays/>

<https://focuslcds.com/journals/7-segment-lcd-displays/>

https://everything.explained.today/Analog-to-digital_converter/

9.0 Appendix

Appendix 1.

<https://docs.rs-online.com/2e20/0900766b816e114c.pdf>

Appendix 2.

<https://docs.rs-online.com/ab70/0900766b8157fd24.pdf>

Appendix 3.

<https://www.analog.com/media/en/technical-documentation/data-sheets/AD74413R.pdf>