

MARKING CRITERIA AND STUDENT FEEDBACK

This section details the assessment criteria. The extent to which these are demonstrated by you determines your mark. The marks available for each criterion 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.

Common Assessment Criteria Applied	Marks available	Marks awarded
1. Research-informed Literature Extent of research and/or own reading, selection of credible sources, application of appropriate referencing conventions.		
Some evidence of reading but missing references.	10	5
2. Knowledge and Understanding of Subject Extent of knowledge and understanding of concepts and underlying principles associated with the discipline.		
Task 1 shows some understanding though missed some key points such as noise and temperature. Task 2 b1 is somewhat confused!	50	25
3. Analysis Analysis, evaluation and synthesis; logic, argument and judgement; analytical reflection; organisation of ideas and evidence		
Some analysis in T4.	10	3
4. Practical Application and Deployment Deployment of methods, materials, tools and techniques; application of concepts; formulation of innovative and creative solutions to solve problems.		
Some use of Matlab demonstrated however No Hand calculations	25	15
5. Skills for Professional Practice Attributes in professional practice: individual and collaborative working; deployment of appropriate media; presentation and organisation.		
You should try to use equation editor and Proof read your submission work.	5	2

Assignment Mark Overall (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)		50 %
	Up to one-week late		
	Over one week late		



07/03/2018

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Dynamics, Control and Instrumentation

1.

a) The amount of deformation of a body due to a force applied is called Strain. Strain can be both tensile or compressive although when dimensionless strain is measured it is expressed in units of Inches/mm. When applying a given force to a structure the length of the structure will change, Strain is the ratio of this change in dimension. To measure the change a Strain gauge which is glued to the structure is used. If there is any distortion to the material it will have a knock on effect and cause a distortion of the strain gauge. Containing conducting material the gauge's distortion will result in a change in its resistance. To measure a strain along a length of steel is to place two gauges on two different sides of the steel. The gauge will measure the length on one side and the depth and also width along the other, units used is ohms (resistance). The strain gauges have a set resistance value when installed as this is because it would not get recorded without a datum as the results would be unreliable. To measure the change in resistance a Wheatstone bridge circuit is used (See Fig 1.) As shown below each arm has a resistor of a known resistance (R_1 , R_2 , R_3 , R_4) or a strain gauge. The gauge will occupy 1, 2 or 4 of the arms. A factor which may change the resulting resistance is the temperature, but computerised systems are able to automatically compensate for that factor. If R_1 , R_2 , R_3 and R_4 are all equal and a voltage V_{in} is applied between the points of A and also C, then the output between points B and D will not have a potential difference. However if R_4 is changed to a value that does not equal that of R_1 , R_2 and R_3 then the bridge will become unbalanced and a voltage will then exist at the output terminals.

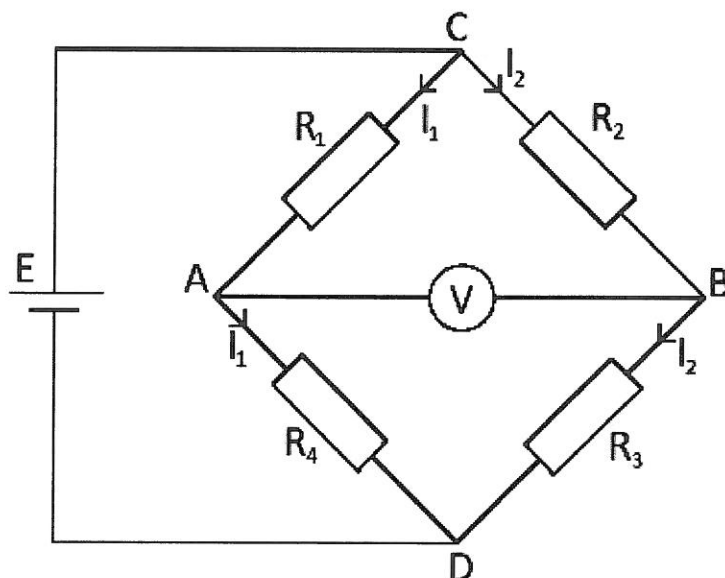


Fig 1.

Task 1

b)

Loads applied 1.5 MN + 2.5 MN
Modulus of Elasticity 210 GPa

Youngs modulus = E

$$\text{Stress } (\sigma) = \frac{F}{A} \quad \text{Strain } (\epsilon) = \frac{\Delta x}{x}$$

$$\text{Area } (A) = 100 \text{ mm} \times 50 \text{ mm} = 5000 \text{ mm}^2$$

$$\text{Force } (F) = 1.5 \text{ MN}$$

$$\text{Elasticity } (E) = 210 \text{ GPa}$$

$$\text{Length of bar } = 2 \text{ m}$$

$$1.5 \text{ MN of force} = \Delta x = 2.86 \times 10^{-3} = 2.86 \text{ mm}$$

$$2.5 \text{ MN of force} = \Delta x = 4.8 \times 10^{-3} = 4.8 \text{ mm}$$

$$\text{Stress } \sigma = \frac{1.5 \times 10^6}{5 \times 10^{-3}} = 0.3 \times 10^9 \text{ Pa}$$

$$\text{Youngs Modulus} = E = \frac{\sigma}{\epsilon} \quad \text{Strain} = \frac{0.3 \times 10^9}{210 \times 10^9}$$

$$= 1.43 \times 10^{-3}$$

$$\Delta x = (\epsilon \times L) = 1.43 \times 10^{-3} \times 2 \text{ m} = 2.86 \times 10^{-3}$$

Applied force = 2.5 MN

$$\text{Stress } \sigma = \frac{2.5 \times 10^6}{5 \times 10^{-3}} \quad \text{Strain } \epsilon = \frac{0.5 \times 10^9}{210 \times 10^9}$$

$$= 0.5 \times 10^9 \text{ Pa} \quad = 2.4 \times 10^{-3}$$

$$E = \frac{\Delta x}{x} \quad \Delta x = E \times x$$

$$= 2.4 \times 10^{-3} \times 2 \text{ m} = 4.8 \times 10^{-3}$$

(3)

2.

a)

With regards to control systems a set point is the target value for an essential variable of a system which is often used to describe a standard configuration for the system. An example of this term is that a boiler may have a temperature set point, which is the temperature the boiler control system aims to maintain. ✓

Overshoot is an output exceeding its final steady state value. With regards to step input, the percentage overshoot is the maximum value minus the step value which is divided by the step value. The overshoot is just the maximum value of the step response minus one. ✓

A plant within control systems is the combination of both actuator and process. Often referred to with a transfer function which suggests the relation between an input and output signal of a control system without any feedback. ✓

Control Variable is a variable that is kept at a constant in order to measure or clarify the relationship between two other variables. Determining when and to what extent to influence it is the Control. Temperature is called the Controlled Variable, the output of the system. Its desired value (25° C) is called the Set Point. Temperature is here also an Input Variable, since it is measured by a thermometer to know the current value of temperature. ✓

A controller is a device which may use mechanical, hydraulic, pneumatic or electronic techniques often in combination, but more recently in the form of a microprocessor or computer, which monitors and can physically alter the operating conditions of a given system. ✓

Control law is a formula used by a controller to determine the output that is sent to the plant. Control law is usually part of the controller which takes the output of a process that it wants and controls it as an input. For example, in a cruise control system, the control law compares the reference speed to the current speed and uses this error in a PID control algorithm to determine the signal that is then sent to the actuators to decrease the error between the desired and actual speed. ✓

(10)

b)

A transfer function that is electrically controlled can also be recognised as a system function. After reading the incoming signals have been read an output signal is sent out in response. The output signals will then control a system on a piece of equipment/item.



Some examples include;

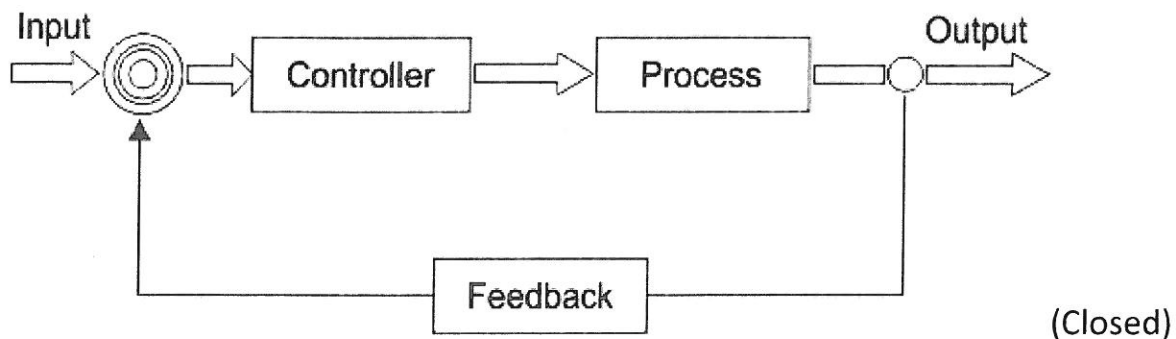
Electric Oven – The ovens temperature is set using the given controls, once a temperature is set the large coil wires are heated up to the given temperature.

Electric guitar amplifier – By changing the audio frequency you will be able to get different levels of volume produced by the amplifier.

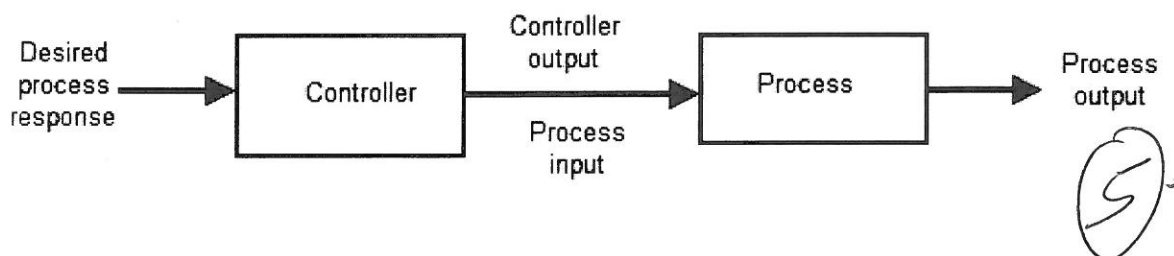
Boiler Thermostat – Turning the temperature up on the controls will energise the boiler and it will start to produce hot water through the heating.

c)

A closed loop system is also referred to as a feedback system. The system uses the concept of an open loop as its forward path but will have one or more feedback loops or paths between its output and input. Some of the output is returned to the input to hence the name 'feedback'. The closed loop systems are created in a way that it will automatically achieve the output condition by comparing it with the actual condition. By generating an error signal which is the difference between the output. A closed loop system is a fully automatic system which is control action is dependant of the output.



An open loop system is referred to as a non-feedback system. The system is a continuous control system as the output has no influence or effect on the control action of the input signal itself. Open loop systems are expected to follow its input command, having no knowledge of the output condition so the system cannot correct any errors it could make when the present value drifts. A disadvantage of the open loop system is that they are very poorly equipped to handle changes in conditions which may reduce its ability to complete the task it has been given. For example the oven may have a timer set to 30 minutes but the door has is open and heat is lost. The timing controller will continue regardless desired 30 minutes but the food is not cooked at the end of the 30 minute cycle. This is because there is no information fed back to maintain a constant temperature. ✓



(Open)

d)

A closed loop system will watch the output by adjusting the set point to the appropriate amount needed to get the specific output. Using a closed loop system you are able to control the parameter that you intend to control yourself (e.g. temperature of an oven). Unlike the closed loop systems, open loop are inaccurate and are also unreliable. The changes in the outputs due to external disturbances are not corrected automatically whereas to the advantage of the closed loop systems, they are able to do this function. The sensitivity of a closed loop system can be made smaller to ensure that the system itself is more stable. ✓



3.

a)

Linear displacement is an electrical device which is used to convert mechanical motions or mechanical vibrations into a variable electrical voltage/current. The device can control the output of the voltage also. ✓

Rotation displacement is the opposite to the linear displacement transducers as the transducer provides alternating current output voltage. ✓

A sensor/transducer that can measure pressure (Pa) is called a strain gauge. Electrical resistance can vary in proportion to the amount of strain on the Strain gauge. The increase in resistance will then increase the strain. ✓

The distance or a presence of an item can be detected using a presence sensor. Ultra-sonic sensors, proximity sensor, presence sensing safety devices are some of the sensors which are available to purchase. ✓

Using accelerometers that contain a piezoelectric crystal element vibration can be measured. When a force such as vibration is applied to the accelerometer the mass compresses the crystals inside of the accelerometer and an electric signal is produced. The system is calibrated routinely so that a known electrical signal is an accurate representation of the result. ✓ (H)

b)

Using a 4-20mA system will have many advantages but the stand out advantage is the range of voltages. Whereas the 0-10V system does not have that advantage as you are restricted to the amount of voltage use. It also has low electromagnetic susceptibility and it can also then be fed over long distances and compared to voltage type signals these lose a lot of signal over longer distances. ✓ (2)

4)

a)

With regards to the term stability in relation to control systems, a finite sized input is applied to a system where its output should also be finite and not infinite. Which means that a system which is defined as stable should every bounded input produces a bounded output. A system can also be defined as stable when it is the subject to an impulsive input the out will die away to zero as the time tends to infinity. Although, if following on the impulse input, the system output tends to infinite as well as the time the system is unstable.

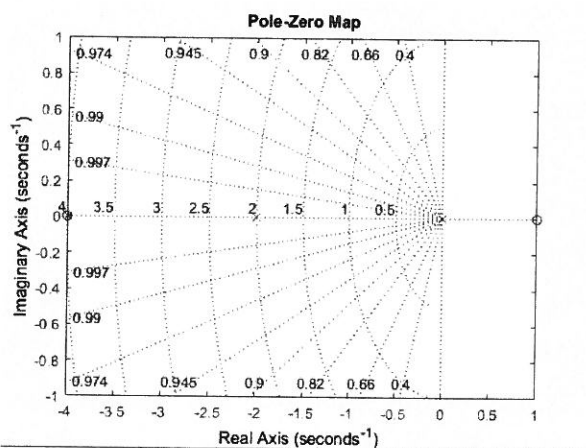
✓
⑤-

b)

- i) The graph titled pole-zero map is showing that it is stable due to no poles being on the right hand side

```
1 -   SYSN = [1 3 -4]
2 -   SYSD = [3 18 24 0]
3 -   L = tf ([SYSN],[SYSD])
4 -   Nroots = roots(SYSN)
5 -   Droots = roots(SYSD)
6 -   pzmap(L)
7 -   grid on
```

✓



③ 2

>> T1

SYSN =

1 3 -4

SYSD =

3 18 24 0

L =

$$s^2 + 3s - 4$$

$$3s^3 + 18s^2 + 24s$$

Continuous-time transfer function.

Nroots =

-4

1

Droots =

0

-4

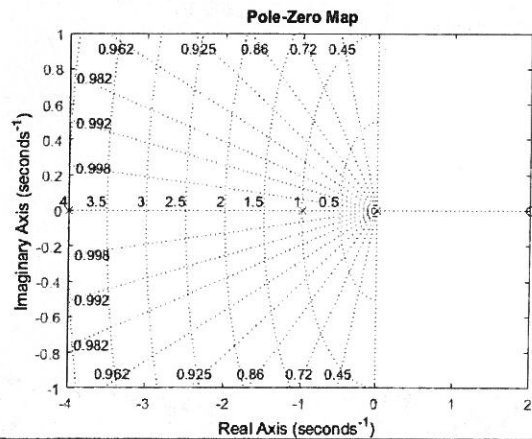
-2



- ii) The graph titled pole-zero map is showing that it is stable due to zero points on the right hand side and all of the X's on the left hand side of the real axis



```
SYSN = [1 -2 ]
SYSD = [1 5 4 0]
L = tf ([SYSN],[SYSD])
Nroots = roots(SYSN)
Droots = roots(SYSD)
pzmap(L)
grid on
```



(3) 2

2.m x +

```
>> T2
```

```
SYSN =
```

```
1 -2
```

```
SYSD =
```

```
1 5 4 0
```

```
L =
```

```
s - 2
```

```
-----
```

```
s^3 + 5 s^2 + 4 s
```

Continuous-time transfer function.

```
Nroots =
```

```
2
```

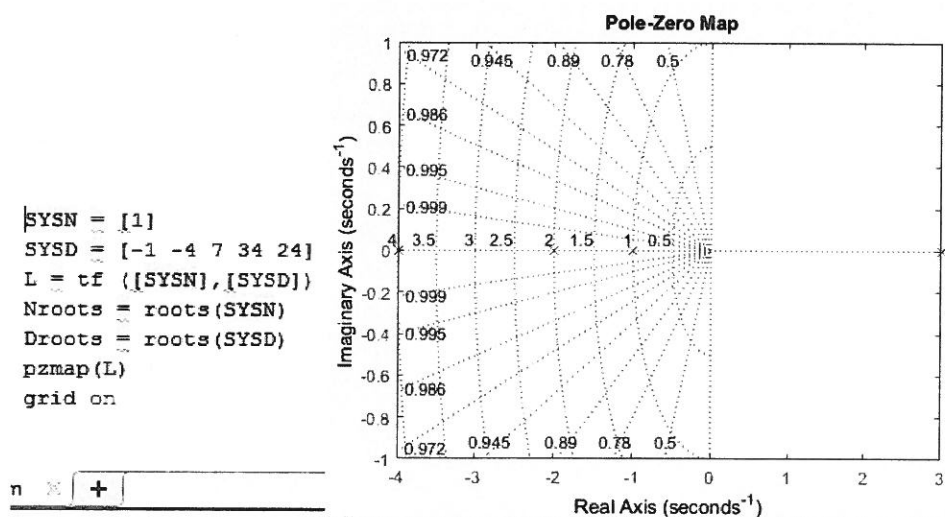
```
Droots =
```

```
0
```

```
-4
```

```
-1
```

- iii) As well as this is unstable due to a pole being on the positive side of the real axis



>> T3

SYSN =

1

SYSD =

-1 -4 7 34 24

L =

-1

$s^4 + 4s^3 - 7s^2 - 34s - 24$

Continuous-time transfer function.

Nroots =

0x1 empty double column vector

Droots =

3.0000

-4.0000

-2.0000

-1.0000

