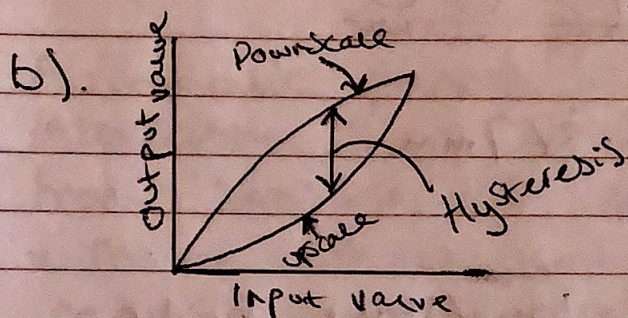


Nathan Scott & Morgan (1902731)
ACMA5001

07/01/2022

09:33am

Q1. a) The transducer produces an output which is related to the measurand and is normally proportional.



Hysteresis is a dynamic response, that causes the movement between loading and unloading to be different. Also known as hysteresis error.

c). ~~Change~~ The change in gauge wire causes proportional change in the resistance of the strain gauge. As pressure increases, the gauge wire is pushed out, causing a change in displacement (distance of wire from metal). This changes the resistance proportionally.

Natha Scott Mayer (1902731)
ACMASB01

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d). i) $k = k_1 \times k_2 \times k_3 \dots$

$$K = 75 \times 10^{-3} \times 150 \times 10^{-3} \times 100 \times 1.78$$

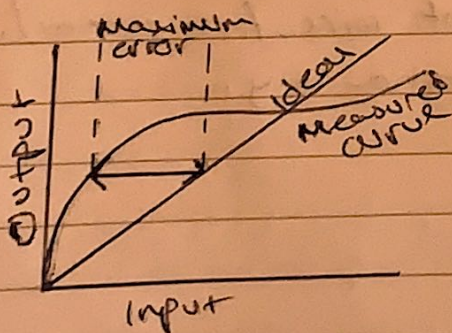
$$K = 2.0025 \times \text{mA/mm} \times \text{mV/A} \times \text{V/V} \times \text{cm/hr}$$

$$K = 2.0025 \text{ cm/mm} \times \text{mA/mm} \times \text{mV/A}$$

ii) $\frac{12.75 \times 12.75}{2.0025} = 6.367 \text{ mm}$

iii). The function of the Wheatstone bridge element is to measure an unknown resistance. It can also convert a change in resistance to a corresponding change in Voltage.

e). Non-linearity: relationship of output/input being truly linear is rare. When an output curve is produced, the maximum error can be determined for either input or output.



Ideal line show proportional between input and output. Measured curve shows the "reality".

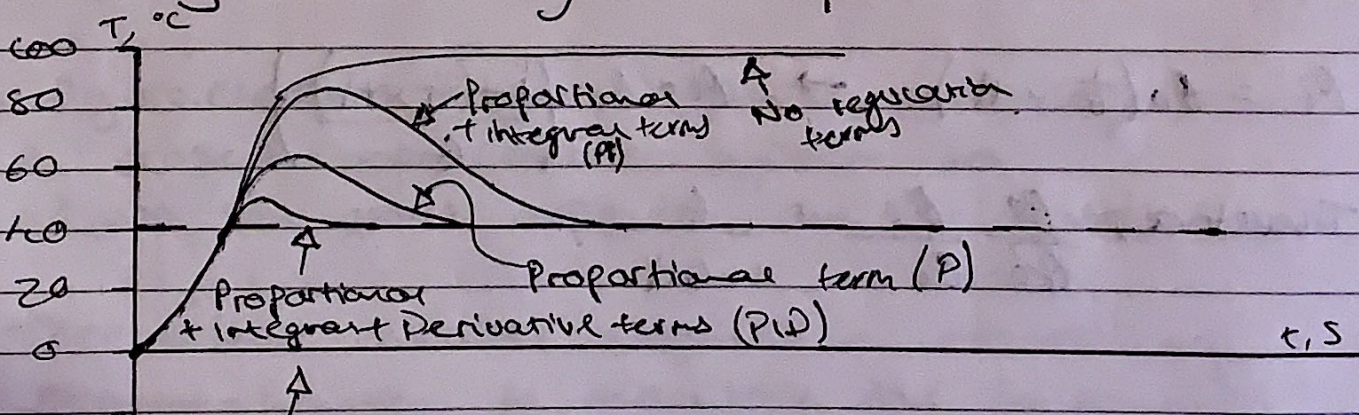
$$K = \text{Out} / \text{input}$$

Nathan Scott Morgan (1902731) 10:09
ACMA5001

Q2. a). A control system is comprised of subsystems (~~of~~ elements) and processes (~~of~~ plants) assembled for the purpose of controlling the output of the processes.

Automatic process control require no manual intervention. These systems run on feed back from sensors and can run autonomously with or without manual intervention, 24 hours and 7 days a week. They can therefore they can gather data (information) more efficiently.

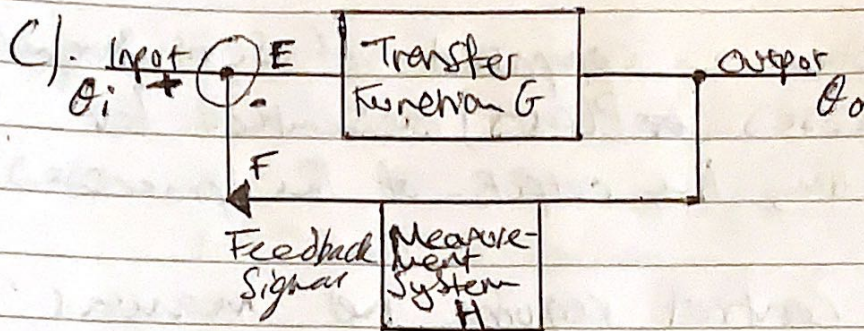
b). A PID controller is a combination of 3 control modes which allow a controller to ~~take~~ take no offset error, ~~and~~ therefore reducing the tendency for output oscillations.



As you can see, the combination of all modes bring down the signal response which reduces the oscillation after it's initial peak.

Nathan Scott Mense (1902731)
ACMA 5001

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$$G = \frac{O_o}{E} \quad \text{Transposed to} \quad E = \frac{O_o}{G}$$

$$H = \frac{F}{O_o} \quad \text{Transposed to} \quad F = H \times O_o$$

$$E = O_i - F$$

$$\frac{O_o}{G} = O_i - (H \times O_o) \quad \text{Transposed so } O_i \text{ is subject}$$

$$O_i = O_o \left(\frac{1}{G} + H \right) \rightarrow O_i = O_o \left(\frac{1 + (G \times H)}{G} \right)$$

$$\text{Therefore, } \frac{O_o}{O_i} \frac{O_o}{O_i} = \frac{G}{1 + GH}$$

Nathan Scott Muyen (1902731)
ACMA 5001

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d) $G_1 = 10 \text{ mA/V}$
 $G_2 = 2.5 \text{ mm/mA}$
 $H = 150 \text{ mV/mm}$

Overall System Transfer Function?

Given as $= \frac{\theta_o}{\theta_i}$

$$\frac{\theta_o}{\theta_i} = \frac{G_1 G_2 H}{1 + G_1 G_2 H}$$

$$\frac{\theta_o}{\theta_i} = \frac{10 \times 10^{-3} \times 2.5 \times 10^{-3}}{1 + 10 \times 10^{-3} \times 2.5 \times 10^{-3}}$$

$$\frac{\theta_o}{\theta_i} = 2.5 \times 10^{-5} \times \text{mA/V} \times \text{mm/mA} \times \text{mV/mm}$$

$$\frac{\theta_o}{\theta_i} = 2.5 \times 10^{-5} \text{ mV/V}$$

e) Hydroelectric Power Stations, ~~are~~ require a closed loop control system to adjust the gates depending on the water level.

Thermostat heater requires a closed loop control system to maintain the temperature in a working environment or machinery such as applying ~~to~~ lubrication to a pillar drill or a lathe.

Q3 a) $G_1 = 15$

$G_2 = 0.35 \text{ rpm/v}$

11:33:13

~~$$ESS = O_i \left(\frac{G_1 G_2}{1 + G_1 G_2 H} - 1 \right)$$~~

 ~~$\ominus$~~

~~$$0 = O_i \left(\frac{15 \times 0.35}{1 + 15 \times 0.35 \times H} \right)$$~~

~~$$0 =$$~~

i)
$$ESS = O_i \left(\frac{G_1 G_2}{1 + G_1 G_2 H} - 1 \right)$$

$$\text{So, } \frac{15 \times 0.35}{1 + (15 \times 0.35)H} = 1.25$$

$$\text{So, } 1 + (15 \times 0.35)H = (15 \times 0.35)$$

$$\text{therefore } H = \frac{4.25}{5.25} = 0.81 \text{ rpm/v}$$

ii) $15\% \text{ of } 15 = 2.25$

$15 - 2.25 = 12.75$

$$ESS = O_i \left(\frac{G_1 G_2}{1 + G_1 G_2 H} \right) \text{ so, } O_i \left(\frac{12.75 \times 0.35}{1 + (12.75 \times 0.35 \times 0.81)} \right)$$

$ESS = 0.97 O_i$

$\text{Reduction} = 3.2\%$

$$b) i) \frac{di}{dt} + \frac{R}{L} i = \frac{V}{L} \quad \#$$

$$i = \frac{di}{dt} + \frac{R}{L} - \frac{V}{L}$$

c) $\tilde{y}(t)$ = transient Response

$\bar{y}(t)$ = Steady-State response

$\tilde{y}(t)$ occurs as a result of a change in the system input and generally dies away after a short interval of time.

$\bar{y}(t)$ that which remains after all transient responses ($\tilde{y}(t)$) have died down completely.

