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(ACMA5001)
Control & Automation
exam

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Q 4(a)

$$7.5 \frac{d^2 \theta_0}{dt^2} + 40 \frac{d\theta_0}{dt} + 300 \theta_0 = 800 \theta_i$$

$$\frac{7.5}{7.5} \frac{d^2 \theta_0}{dt^2} + \frac{40}{7.5} 2\zeta \omega_n \frac{d\theta_0}{dt} + \omega_n^2 \frac{300}{7.5} = 800 \omega_n^2 \theta_i$$

$$\omega_n^2 \frac{300}{7.5} = \omega_n \sqrt{\frac{300}{7.5}} = 6.325 \text{ Hz}$$

$$2\zeta \omega_n \frac{40}{7.5} \therefore \zeta = \frac{40}{2\omega_n \times 7.5} = \frac{40}{2 \times 6.325 \times 7.5} = 0.4216$$

So $\zeta = 0.4216$ So, System is under damped.

$$(b) \exp\left(\frac{-\zeta \pi}{\sqrt{1-\zeta^2}}\right) \times 100\% = \exp\left(\frac{-0.4216 \times \pi}{\sqrt{1-0.4216^2}}\right) \times 100\%$$

= 0.232 or 23.2% peak overshoot

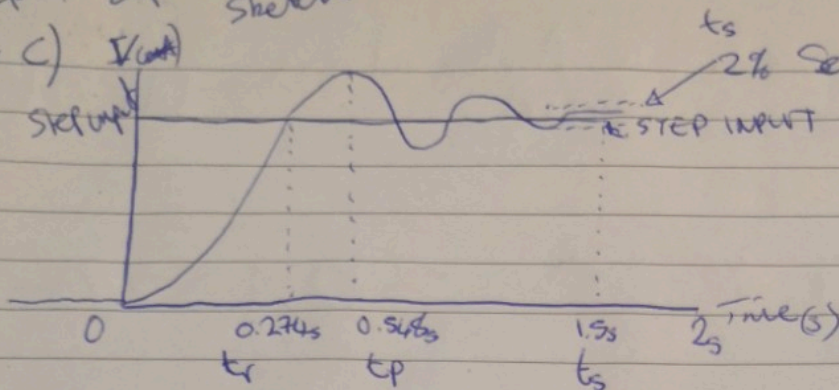
$$\text{Rise time} = t_r = \frac{\pi}{\omega_n \sqrt{1-\zeta^2}} = \frac{\pi}{6.325 \times \sqrt{1-0.4216^2}} = 0.274 \text{ s}$$

$$\text{Peak time} = t_p = \frac{\pi \zeta}{\omega_n \sqrt{1-\zeta^2}} = \frac{0.4216 \times \pi}{6.325 \times \sqrt{1-0.4216^2}} = 0.548 \text{ s}$$

$$\text{Settling time } 2\% \quad t_s = \frac{4}{\zeta \omega_n} = \frac{4}{0.4216 \times 6.325} = 1.5 \text{ s}$$

12/02/21 2d S
4 c) I (mA)

Sketch



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4 d) 15% $\zeta =$

$$\ln 0.15 \div -1.897 \left(\frac{-\zeta \omega_n}{\sqrt{1-\zeta^2}} \right) a$$

15% damp decimal

$$\therefore -1.897 \sqrt{1-\zeta^2} = -\zeta \omega_n \quad -1.897 \pm \frac{a}{b} = -1.897 b = a$$

$$\frac{-1.897^2}{= 3.599 (1-\zeta^2)} = 9.87 \zeta^2 \quad \therefore \zeta^2 = \frac{3.599}{13.467} = 0.26$$

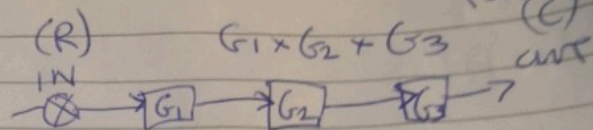
$\therefore \zeta = \sqrt{0.26} \therefore \zeta = 0.52$ which is required to ensure the maximum peak overshoot % of 15.

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(C)

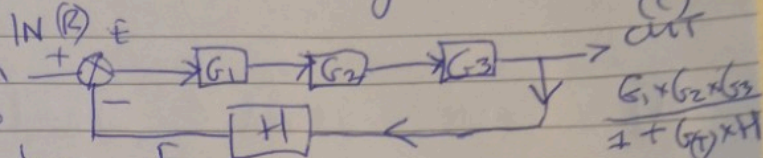
Q 2

(a) open loop System



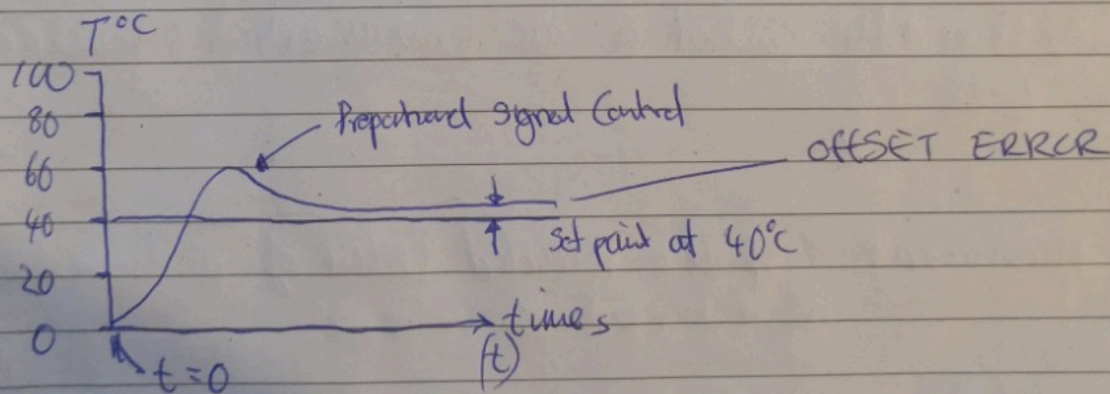
Has no feedback loop so therefore cannot correct for any disturbances in the system. ie tracker

closed loop system
Has the ability to alter the output by used of a feedback loop, in which the error signal E can make adjustment for any disturbance



(b) Proportional Control $\text{Output } C_o = K_p E(t)$

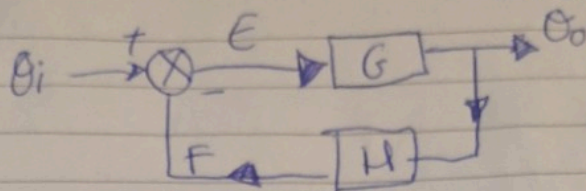
This is a response in proportion to the difference between what is set as the desired process variable known as the set point and the current value of the variable. These system controller strategies can exhibit offset error.



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2(c) $\frac{e_o}{e_i} = \frac{G}{1+GH}$



(d) $G_1 = 5 \times 10^{-3}$ Sensor = 5.0 mA/V Solenoid Valve = 0.25 mm/mA
 G_2
 $H = 150 \times 10^{-3}$ Feedback loop = 150 mV/mm

$$\frac{G_1 G_2}{1 + G_1 G_2 H} = \frac{5.0 \times 0.25}{1 + (5.0 \times 0.25 \times 150)} \frac{0.005 \times 0.25}{1 + (0.005 \times 0.25 \times 0.150)}$$

$= 1.25 \text{ mV/V}$
 $\frac{\text{mA}}{\text{V}} \times \frac{\text{mm}}{\text{mA}} \times \frac{\text{mV}}{\text{mm}}$

- e) 1) OVEN TEMPERATURE CONTROL IN INDUSTRIAL CAKE MAKING PROCESS
 2) Humidity Control in an Environmental chamber test rig.

Q
 1a) Measurement - is the recorded value of a variable at a moment of time

monitoring - a constant assessment of a value within a process.

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1 (b) Systematic errors and Random errors

Systematic - All readings are biased usually occurs from a poor design of the measurement system.

Random - Repeated reading around a mean causes of error unknown

(c) change in dimensions of gauge wire with ^{change} increase in pressure proportional.

(d) $K_1 \times K_2 \times K_3 \times K_4 = \text{overall System Sensitivity}$
 $0.75 \Omega/\text{rad} \times 150 \text{ mV}/\Omega \times 500 \text{ V}/\text{V} \times 1.0 \text{ cm}/\text{V}$

(i) $0.75 \Omega/\text{rad} \times 0.150 \text{ V}/\Omega \times 500 \text{ V}/\text{V} \times 1.0 \text{ cm}/\text{V} = \underline{56.25 \text{ cm/rad}}$

(ii) $\frac{\text{OUTPUT}}{\text{INPUT}} = \frac{C}{R} \quad C = \frac{8.5}{R = 56.25} = \underline{0.151 \text{ rad}}$

(iii) A Wheatstone bridge is used to measure an unknown resistance in a circuit

