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By filling out the names above, the group members acknowledge that a) they have jointly authored this submission, b) this work represents their original work, c) that they have not been provided with nor examined another person's assignment, either electronically or in hard copy, and d) that this work has not been previously submitted for academic credit.			

LAB 2. SECOND-ORDER SYSTEM IDENTIFICATION AND ANALYSIS

ASSIGNED DATA

For easily referencing it, the Assigned Data has been placed at the start of this document.

On your pre-lab and post-lab submissions, always include this page at the beginning of the document.

Select your lab session:	<input type="checkbox"/> morning lab; <input checked="" type="checkbox"/> afternoon lab; <input checked="" type="checkbox"/> Tue; <input type="checkbox"/> Wed; <input type="checkbox"/> Thu	
CourseBook Group Number	45	
Assigned plant number ($Plant\ i = CourseBook\ GroupNumber\ i$)	45	
Plant parameters:	a	2
	b	5
	T	100
	K _i	330

The green highlighting present in this document is meant to draw your attention to things that need to be done.

Pre-Lab

Question 1

By reducing block diagram rules:

$$\begin{aligned}\text{Let } H(S) &= \frac{K_i}{s} \times \frac{bT}{s + aT} \\ &= \frac{K_i bT}{s(s + aT)} \\ G(S) &= \frac{H(S)}{1 + H(S)} \\ &= \frac{\frac{K_i bT}{s(s + aT)}}{1 + \frac{K_i bT}{s(s + aT)}} \\ &= \frac{\frac{K_i bT}{s(s + aT)}}{\frac{s(s + aT) + K_i bT}{s(s + aT)}} \\ &= \frac{K_i bT}{s(s + aT)} \times \frac{s(s + aT)}{s(s + aT) + K_i bT} \\ &= \frac{K_i bT}{s(s + aT) + K_i bT} \\ &= \frac{K_i bT}{s^2 + aTs + K_i bT}\end{aligned}$$

Question 2

Using the standard second order system.

$$\begin{aligned}G(S) &= \frac{\omega_n^2}{s^2 + 2\zeta\omega_n s + \omega_n^2} \\ \omega_n &= \sqrt{K_i bT} \\ 2\zeta\omega_n &= aT \\ \zeta &= \frac{aT}{2\omega_n} \\ &= \frac{aT}{2\sqrt{K_i bT}}\end{aligned}$$

Question 3

With OS in its decimal value.

$$\begin{aligned}
T_p &= \frac{\pi}{\omega_n \sqrt{1 - \zeta^2}} \\
OS &= e^{\frac{-\zeta \pi}{\sqrt{1 - \zeta^2}}} \\
\ln OS &= \frac{-\zeta \pi}{\sqrt{1 - \zeta^2}} \\
\ln OS \times \sqrt{1 - \zeta^2} &= -\zeta \pi \\
\ln^2 OS \times (1 - \zeta^2) &= \zeta^2 \pi^2 \\
\ln^2 OS - \ln^2 OS \zeta^2 &= \zeta^2 \pi^2 \\
\ln^2 OS &= \zeta^2 (\ln^2 OS + \pi^2) \\
\zeta &= \sqrt{\frac{\ln^2 OS}{\ln^2 OS + \pi^2}}
\end{aligned}$$

Question 4a

$$\begin{aligned}
H_{open}(S) &= (K_p \times G(S) + D(S)) \times K \\
&= G(S) \\
&= \frac{K_i b T}{s^2 + a T s + K_i b T}
\end{aligned}$$

Question 4b

$$\begin{aligned}
H_{closed}(S) &= \frac{H_{open}(S)}{1 + H_{open}(S)} \\
&= \frac{\frac{K_i b T}{s^2 + a T s + K_i b T}}{1 + \frac{K_i b T}{s^2 + a T s + K_i b T}} \\
&= \frac{\frac{K_i b T}{s^2 + a T s + K_i b T}}{\frac{s^2 + a T s + K_i b T + K_i b T}{s^2 + a T s + K_i b T}} \\
&= \frac{K_i b T}{s^2 + a T s + K_i b T} \times \frac{s^2 + a T s + K_i b T}{s^2 + a T s + 2 K_i b T} \\
&= \frac{K_i b T}{s^2 + a T s + 2 K_i b T}
\end{aligned}$$

Question 4c

$$H_d(S) = \frac{K}{1 + K \times (R(S) + K_p \times G(S))}$$

$$H_d(S) = \frac{1}{1 + G(S)}$$

$$H_d(S) = \frac{1}{1 + \frac{K_i b T}{s^2 + a T s + K_i b T}}$$

$$H_d(S) = \frac{1}{\frac{s^2 + a T s + K_i b T + K_i b T}{s^2 + a T s + K_i b T}}$$

$$H_d(S) = \frac{s^2 + a T s + K_i b T}{s^2 + a T s + 2 K_i b T}$$

Question 5

Assigned Parameter Value	Select Range Value	ACS13016 Display Value
2	-	20
5	-	50
330	10	33