MOTIONS AND CONTROL OF MARINE VEHICLES

DEN462E

TERM PROJECT

Please read the scenario provided below and answer each question in the given order, using the personalized values listed in the table on the following page. You have three weeks to complete the tasks outlined in this document. Your report should provide a detailed explanation of how you approached the problem, along with presenting graphs in a meaningful manner. Your presentation's quality will also be assessed during grading.

Consider a ship with length $L = s_1$ moving with a forward speed of $U = s_2$. The turning circle tests revealed that this ship achieves a steady turning diameter of $STD = s_3$ at a rudder angle of $\delta = s_4$, and loses s_5 of its speed during this turning.

a. Write down the equation relating the yaw rate to the ship's rudder angle.
b. Calculate the K-index of the ship.

After the turning circle tests, the ship was subjected to a course-keeping test and it was found that the ship is turning at a residual yaw rate of $r_b = s_6$, even at the neutral rudder angle of $\delta = 0°$.

c. Modify the equation in (a) using the residual yaw rate.

You will be developing the time-based course-keeping simulation of this ship for . Take the following as the initial condition of your ship:

$$\psi_0 = \delta_0 = v_0 = x_0 = y_0 = 0$$

Here; ψ is the ship's heading angle, v is the ship's sway speed, x and y are the ship's position in x- and y-axes, respectively.

d. Use a proportional controller to keep the ship at a target heading angle of $\psi_t = 0°$. Take $K_P = 1$. Graph the yaw rate, heading angle, rudder angle, surge speed, and sway speed in time. Plot the ship's trajectory.
e. Do the same using $K_P = 1/(2K)$.
f. Do the same using $K_P = 1/K$. Write down the notable differences observed in the responses of both the ship and rudder.
g. Do the same using $K_P = 2/K$. Please provide an explanation of what happens in this condition and state the reasoning behind it.

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Table of required values for each student

	s_1	s_2	s_3	s_4	s_5	s_6
Units	(m)	$(knots)$	L	(deg)	%	(deg/s)
080170049	125	16	3.25	35	40	0.3
080170054	130	17	2.75	30	45	0.4
080170057	135	18	3.5	25	50	0.5
080180006	140	19	2.5	30	55	0.6
080180013	145	20	3	35	60	0.7
080180015	150	21	3.25	30	40	0.8
080180021	100	11	2.75	25	45	0.3
080180026	105	12	3.5	30	50	0.4
080180027	110	13	2.5	35	55	0.5
080180029	115	14	3	30	60	0.6
080180031	120	15	3.25	25	40	0.7
080180039	125	16	2.75	30	45	0.8
080180051	130	17	3.5	35	50	0.3
080180058	135	18	2.5	30	55	0.4
080190005	140	19	3	25	60	0.5
080190021	145	20	3.25	30	40	0.6
080190034	150	21	2.75	35	45	0.7
080190038	100	11	3.5	30	50	0.8
080190046	105	12	2.5	25	55	0.3
080190710	110	13	3	30	60	0.4
080190713	115	14	3.25	35	40	0.5
080200710	120	15	2.75	30	45	0.6

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