

Zigzag Session Protocol

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1 Introduction and Motivation

In order to understand how to steer a boat, it is necessary to understand how the boat responds to rudder inputs. The methods used in this protocol to measure the response of the boat are adapted from the methods presented in the work of Abkowitz¹ and Lewis².

2 Description

The goal of this session is to perform the zigzag maneuver (also known as *Kempf Overshoot* or “Z” maneuver³) to derive a relationship between the rudder angle, δ , and the rate of rotation of the boat, $\dot{\theta}$. This involves steering the boat in a controlled zigzag pattern.

3 Procedure

The maneuver is conducted as follows:
while rowing,

1. the boat is set travelling straight (rudder angle, $\delta = 0$)
2. the rudder is turned to a set angle ($\delta = \delta_1$) for a set period of time, τ (until the change of rate of rotation, $\dot{\theta}$, is equal to zero [$\dot{\theta} = 0$])
3. the rudder is turned to a set angle in the opposite direction ($\delta = -\delta_1$)

Steps 2 and 3 are repeated a number of times the same rudder angles, δ_1 and the same length of time for the rate of rotation to approach zero, τ .

For this session, the rudder position will be controlled **automatically** by a servo running a programmed course. In this case, $\tau = 15s$ and $\delta_1 = -\delta_2 = 20^\circ$.

¹Martin A. Abkowitz. *Measurement of Ship Hydrodynamic Coefficients in Maneuvering From Simple Trials During Regular Operations*. M.I.T. Department of Ocean Engineering, Cambridge, November 1984.

²Edward V. Lewis. *Principles of naval architecture*. Society of Naval Architects and Marine Engineers, Jersey City, 2nd revision (3rd ed.) 1988.

³Ibid.