# (SS 2014)

## Course Kinematic Measurement Systems

**Task 1: Control System (30%)**

1. Please make a sketch of an detailed closed-loop-system and name the following variables: u(t), w(t), e(t), y(t), z(t). What is the main task of controlled systems?

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1. The alignment of controllers takes an important part in control theory. Please describe the alignment procedure for a system with and without compensation. Which parameters are determined?

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| **General** -Controlled system and controller have to be compatible (e.g. I–system and I–Controller)  -PI–Controller may be used for any system  • P-part shows a fast reaction  • I-part eliminates the control deviation  -PID–Controller delivers better results, but system parameters have to be  aligned precisely (complex procedure)  **Procedure**   1. Identification of controlled system   -Step response experiment 🡪 Identify P or I system  -Calculation of delays: V, TS and TU (graphically)   1. Aligment of controllers   -Without compensation: Vi = Ki  -With compensation: K = V\*(TS/ TU) [Alternative: Ziegler/Nichols table]   1. Estimation of controllability   -TU/ TS !<0.1 |

**Task 2: Modeling of Moving Objects (30%)**

1. Kalman filters are often used in control loops. Name two reasons, why they are used and write down the general equations for the prediction step. Specify the matrices and vectors in the equation.

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1. In general 4 different models are used for modelling of moving objects. Please name them and describe their characteristics. Give an example for each model. Which models are used in general for navigation tasks?

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| **1- Identity/congruence model**  -Discrete movement to determine deformation 🡪Two epochs to analyse individual points  -Time and acting forces ARE NOT considered  **2-Static model**  -Evaluation of two static movements under different acting forces  -Time IS NOT considered  **3-Kinematic model**  -Geometric movements of individual points are described in a time-dependent way.  -More than two epochs considered.  **4-Dynamic model**  -Geometric movement on time-dependent acting forces. |

**Task 3: Robot Tachymeters (40%)**

1. Within the scope of machine control robot tachymeters are used for positioning beside GPS. Modern robot tachymeters consist of a variety of components. Please show the system architecture in a sketch.

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1. Please describe in your own words the difference between Tracking and Positioning of a moving object and give a sketch of the closed-loop-system within the tachymeter for tracking.

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| Tracking is used for determination of the reflector center -in static measurements-, while positioning is performed to give the reflector a position, by measuring the distance to it in order to determine a trajectory in kinematic measurements. |

1. The positioning in kinematic mode is a common method to determine the

position of moving objects. The synchronization time t plays an important role. Please name the steps for determination of t for a tachymeter under laboratory conditions. Give a sketch of the experiment setup

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| -Pre-conditions: velocity and rail coordinates are known.  -Use of high sampling rates.  -Determination of deviations in X-direction between known and measured coordinates.  -Extraction at maximum deviation [d/2]  -Determination of sync time Δt = d/V |