# (Spring 2013)

## Course Kinematic Measurement Systems

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

1. Give a short explanation of the following terms:

- control deviation

- disturbance variable

- open-loop system (give also one example)

- closed-loop system (give also one example)

|  |
| --- |
| **Control deviation:** e(t) deviation between the predicted and measured variables.  **Disturbance variable:** z(t), external disturbances of the system as wind, friction etc.  **Open-loop system:** An open-loop control system, is a type of controller that computes its input into a system using only the current state and its model of the system. Example: Steering.  **Closed-loop system:**  In a closed-loop control system the error signal, which is the difference between the input signal and the feedback is fed to the controller so as to reduce the systems error and bring the output of the system back to a desired value. Example: Robotic Tachymeter |

1. One important part in control theory is the identification of the plant (controlled system). Different basic systems are known (e.g. P or I). Draw the step responses of the following systems: PT 1, PT 2, PDT 1, IT 1, D.

Use sketches.

|  |  |
| --- | --- |
|  |  |
|  |  |

1. In the lecture you have heard about closed-loop systems. Now you have the task to design a closed-control loop for an automated curb and gutter application. The focus is on the height control for the profile which forms the curb (only the up and down movement of the profile). As reference you can use a digital terrain model. Choose a measurement sensor for the height to guarantee a measurement standard deviation of at least 5 mm. Give reasons for your choice. Draw a sketch of your closed-loop system and name all general parts of the closed-loop system and write the terms which you need to solve the curb and gutter application (e.g. reference variable = 3D height model) in the sketch.

**Task 2: Robot Tachymeter (35%) (Spring 2013)**

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 and describe three components in more detail.

|  |
| --- |
|  |

1. For automatic target recognition fine pointing is used when rough pointing is finished. The line of sight of the tachymeter to the reflector should be as near as possible to the reflector center. In general, two procedures are known. Please explain the one which is based on time measurement and name one manufacturer which uses this kind of fine pointing.

|  |
| --- |
| **Time measurement (Topcon)**  -Range vision by automatic laser beam  -Δt between the start and finish of signal reflection is transformed into (ΔX’ ΔY’)  -(ΔX’ ΔY’) > (ΔHz ΔV) > Correction of readings (Hz V) |

1. Describe the difference between synchronization error and dead time for a robot tachymeter with your own words. You may use sketches.

|  |
| --- |
| - Dead time is the time needed to communicate the data transmission.  - Synchronization error appears due the time difference between different durations of measurement sensors. (Reduced by starting the measurements at different times for each sensor) |

**Task 3: Machine Control for Construction Applications (25%)**

1. Due to a road construction task you have to use a robot-tachymeter for the control of a grader. You know that the grader moves with a velocity of 40 cm/s. Please determine the maximum allowed delay time for the robot-tachymeter, if for positioning a maximum deviation of 2 cm has to be reached.

|  |
| --- |
| v=d/t=2/40=0.05s |

1. In general, for construction machines two kinds of classification systems exist; one according to degree of automation and another one according to the number of dimensions. Please name the two classification systems and their sub divisions and give short descriptions of all classifications and sub divisions.

|  |
| --- |
| 1- Automation: describes the autonomy degree of the system  a-Indication/Guidance: only gives information on guidance to the driver, who steers the system.  b-Semi-automatic: controls height and slope of the system automatically, driver controls position.  c-Automatic: total automatic control of the system.  2- Dimension: describes the number of controlled parameters   1. 1D: controls height 2. 1.5D: controls height and slope 3. 3D: controls height, slope and position |