

Mid-term Exam 1

(75 min for the exam + 15 min for submission)

Date: Apr.24.2023**ŞEREF SÖZÜ BİLDİRGESİ**

Onurum ve şerefim üzerinde yemin ederim ki, bu final sınavını kendi başıma yaptım. Sınav süresi boyunca bu sınav ile ilgili olarak kimse ile herhangi bir görüşme, yazışma, elektronik mesajlaşma, sesli görüntülü veya fotoğraf paylaşımlı herhangi bir iletişimde bulunmadım.

HONOR CODE STATEMENT

I swear on my honor that I made this final exam on my own. During the exam, I did not make any communication with others such as, text sharing, electronic messaging, audiovisual, or photo sharing.

Tarih / Date:

İmza / Signature *:

Ad-Soyad / Name-Surname:

Numara / Number:

*** If you cannot sign it electronically write it (English or Turkish sentences, not both) on a paper and sign it please.**

- You should solve the questions on A4 papers that you have prepared before. **Each question will be solved on separate pages.** "Number", "Firstname & Lastname" and "Question Number" will be written on each page.
- At the end of the exam, the solution will be uploaded via the online system module.
- Solutions of the exam questions should be obtained and named appropriately (via camera or scanner) (eg Solution1). With these images, a single pdf document can be created. Or these images can be put in a folder and a zip file can be created.
- When naming the pdf document or the zip file you created, and the title in the e-mail, etc. Use the following string **Number_Firstname_Lastname_KOM452070_Exam1**

1. (35 points)

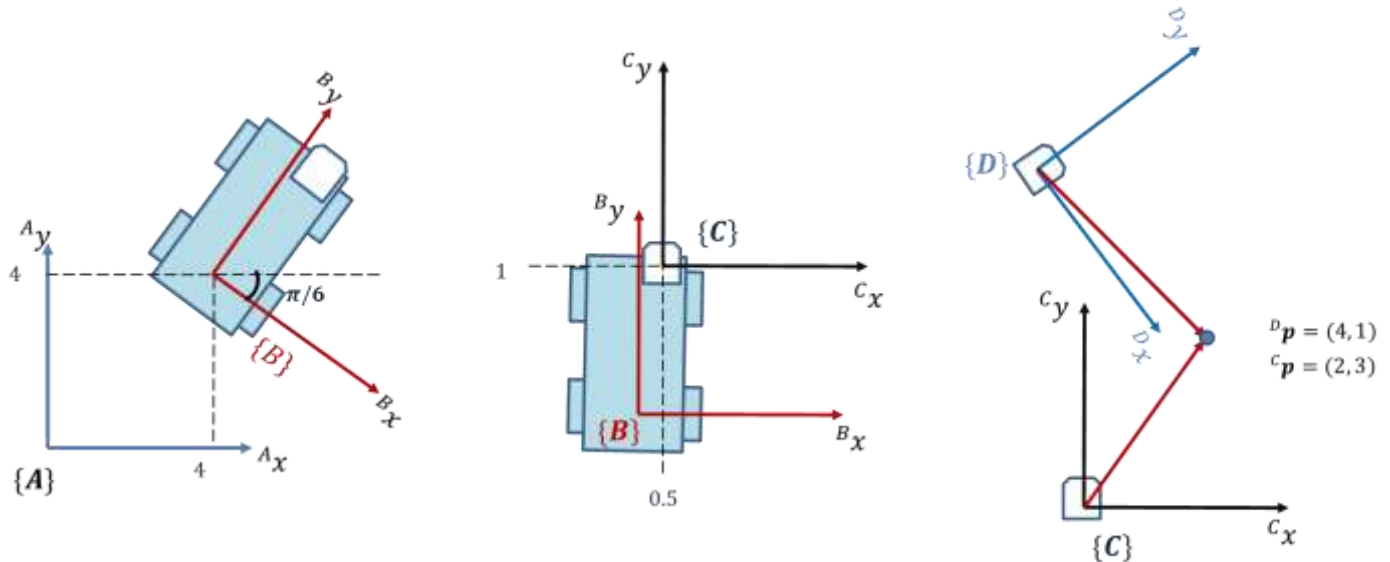
a) Given four coordinate systems:

$\{A\}$ reference coordinate system $\{B\}$ body coordinate system

$\{C\}$ camera1 (attached to the body) coordinate system

$\{D\}$ camera2 coordinate system

Find the poses ${}^A T_B$, ${}^B T_C$, ${}^C T_D$, ${}^A T_C$, ${}^A T_D$ and points ${}^B p$, ${}^A p$
(indicate if any of these matrices cannot be computed with the given)



b) Describe these sets and give examples:

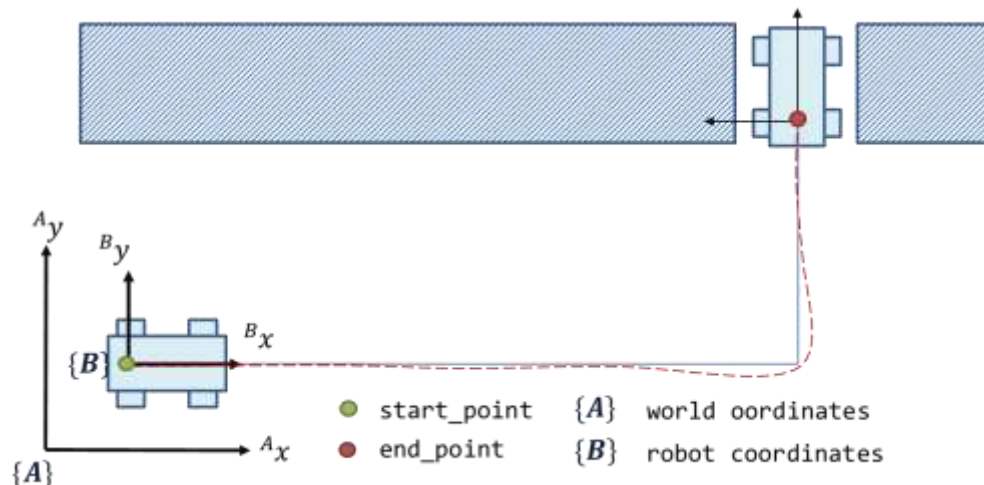
special orthogonal group of dimension 3 ($SO(3)$)

special Euclidean group that represents rigid body motions in 3D ($SE(3)$)

2. (30 points) Using the bicycle model of a car (non-holonomic vehicle), describe the components of the control problem for the task (parking) illustrated below.

- The kinematics of the vehicle as well as the controls for the task should be stated.
- Moving to a point with a specific orientation should be utilized. The velocity should decrease if the distance to the end point decreases.

No Simulink block - No code, just the equations of your design.



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3. (20 points) Write down the mathematical expression for **2-dimensional Gaussian function** using image coordinates variables (u, v) .
- a) Find the derivative of the Gaussian (DoG)
 - b) Find the Laplacian of the Gaussian (LoG)
 - c) Write pseudo code to implement Template Matching considering any of the studied similarity measures.
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4. (15 points)

- a) Explain two broad navigation categories; Reactive Navigation and Map-Based Navigation.
 - b) Describe the term “Bratberg Vehicle”.
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