School of Engineering and Applied Science (SEAS), Ahmedabad University

Name: _____ Roll no.: _____

ENR508 **B. Tech. (CSE, Mech.): Semester 6 and 8**

Subject Name:Mobile Robots, Let's Build One! End Term Exam (Winter Sem .:2024); Marks:30 , Wt.:30 %

April 23, 2024, Tuesday, 11.00 AM – 12.30 PM

Instructions:

1 All questions are compulsory.
2 Figures to the right indicate full marks.
3 All acronyms and symbols carry their usual meaning.
4. A cheat sheet is allowed as per the shared template.
5. Return your question paper and cheat sheet.

Q-1. What is Observability? Is the given system observable or not? Prove it. [4]

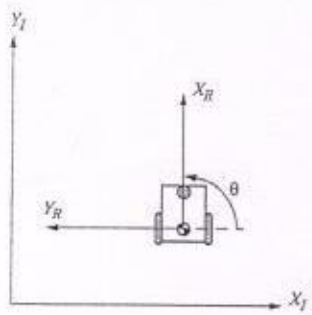
$$\dot{x} = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix} x$$
$$y = [1 \quad 2]x$$

Q-2. Consider the robot Aldebaran Nao, which was given as an example. [5]

$$\ddot{\theta} = \frac{1}{J}(Ki - b\dot{\theta})$$

State parameters: $x = \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} \theta \\ \dot{\theta} \end{bmatrix}$; Measurement: $y = \theta$. Describe this system in state space form and prove if the system is Completely Controllable or not.

Q-3.What is the instantaneous rotation matrix R for the robot in the given pose. What is the state in the global reference frame? What is the velocity of the state in the global reference frame and in robot's frame? [4]

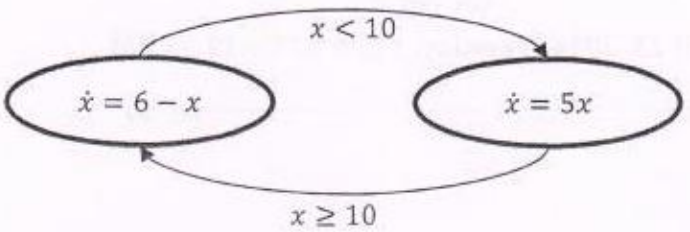


Q-4. Linearise the given system around two operating points $x_1 = x_2 = 0$ and $x_1 = 1, x_2 = -1$. [4]

$$f(x) = \begin{bmatrix} f_1(x_1, x_2) \\ f_2(x_1, x_2) \end{bmatrix} = \begin{bmatrix} x_1 - x_1^2 \\ x_1 + x_2 \end{bmatrix}$$

Q-5. Let's assume that the eigenvalues of the controller are set as $-1 \pm 2j$. Knowing that observable should be faster that controller, where will you place the poles of observer? Plot the poles. [3]

Q-6: In the given hybrid automata, the system will experience the type 1 Zeno effect. Firstly, prove that this statement is true. Second, find the sliding mode dynamics. [4]



Q-7: Kalman and Markov are both probability-based localisation methods. Explain the differences. [3]

Q-8: Name one exteroceptive sensor that you have used in your model of the project. Explain the working principle. [3]

All the best
