BRAC UNIVERSITY

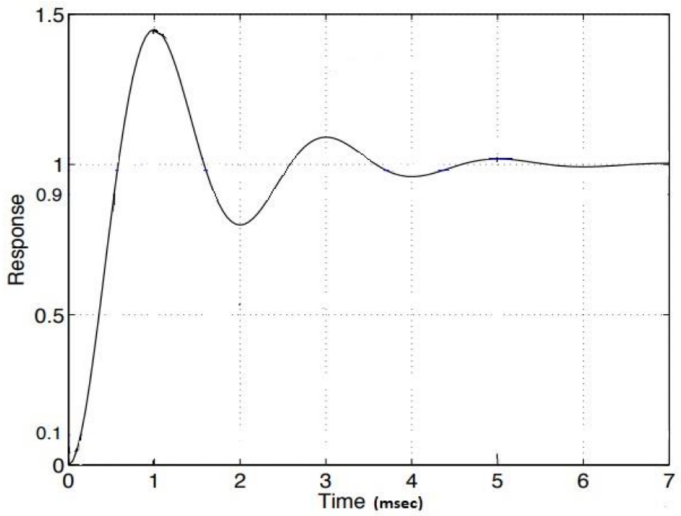
Department of Computer Science and Engineering

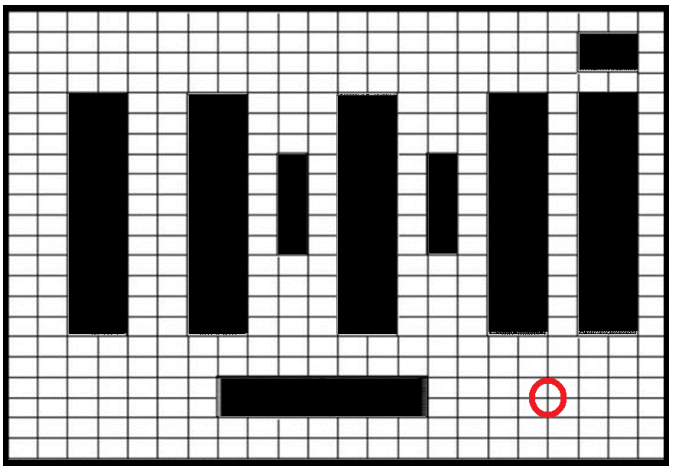
Examination: Final **Duration: 1 Hour 30 Minutes**
Semester: Fall 2023 **Full Marks: 30**

CSE 461: Introduction to Robotics

Answer any three questions out of four

1. (CO3)	In the context of a Convolutional Neural Network (CNN) for image classification of animals, consider an image with a size of 5x5 pixels, and a filter of 3x3 dimensions has been provided below. Assuming the scenario involves classifying images of cats, dogs, and elephants using CNN, explain the process of applying this filter to the image and how it contributes to the classification task. Specifically, describe the convolution operation in determining whether the image contains a cat, dog, or elephant. Input Feature Map 3 5 2 8 1 9 7 5 4 3 2 0 6 1 6 6 3 7 9 2 1 4 9 5 1 Convolutional Filter 1 0 0 1 1 0 0 0 1 a) What is the resulting feature map (X) after doing the convolution? **[4 Marks]** b) Suppose, we have applied a 2x2 average pooling on the feature map (X), what will be the final feature map (X')? **[3 Marks]** c) Suppose we flattened the final feature map (X') and fed it into a neural network which has two hidden layers. First hidden layer has 2 neurons and the second hidden layer has 3 neurons in it. Draw the neural network architecture. **[3 Marks]**	**10**

2. (CO2)	 a) Determine the Overshoot, Rise Time and 5% Settling Time from the Unit Step Response diagram given above. **[6 Marks]**  b) You are tasked with designing a feedback control system. After experimentation, you observed that the designed system controller has a gain of 10 and the feedback sensor has a gain of 4. For an input of 15 units, determine the output of the system. **[2 Marks]** c) Differentiate between Open and Closed loop Control System with suitable examples. **[2 Marks]**	**10**
3. (CO2)	a) How the main components of Navigation integrate each other to implement a Navigation system in Robotic solution? You can answer by a case study. **[3 Marks]** b) Using the following picture where black blocks mean occupied space and red circle means your rover, Explain the occupancy grid algorithm. **[3 Marks]**	**10**

	 c) Suppose you have a water bottle placing robot in the cricket ground where you have to reach a GPS location and you have to find an 'X' mark spot where you drop the water bottle. How Bug based algorithm and Visual homing algorithm can help you to perform this task? Justify whether Dead-Reckoning or LandMark based localization technique will be best fit for this application? **[4 Marks]**	
4. (CO1, CO2, CO3)	If you enhance the above delivery robot to a certain extent to deliver drinks to the players directly from the outside of the rope when the players show a gesture to the robot. (a) What kind of image processing and AI algorithm can be used to understand the gesture of the players, why? **[2 Marks]** (b) What kind of technique can be used to detect the rope so that the robot does not enter inside the field? Explain the whole technique. **[3 Marks]** (c) How many degrees of freedom (DOF) can be used on the arm to deliver the water bottle to the player, why? **[2 Marks]** (d) Which of the following two types of robot will be preferable for this purpose, why if they have similar type of arm? **[2 Marks]**   (e) What other sensors can be used if we want to make it fully autonomous? **[1 Marks]**	**10**