BRAC UNIVERSITY
Department of Computer Science and Engineering

Examination: Quiz-4
Duration: 25 minutes

Semester: Spring 2023
Full Marks: 15

CSE 461: Introduction to Robotics

Name:	ID:	Section:

1. **[5 marks]** You have 3 types of cleaner robots and you want to suggest to the buyers a specific type based on some criteria. Hence you want to develop an ML model for this purpose. Luckily, you found a dataset, part of which is like below.

Building Type	Number of rooms	Tiles/Mosaic	Has Stairs	Preferred Type
Apartment	4	Tiles	No	C
Office	10	Tiles	No	A
Industry	25	Mosaic	Yes	B
...	...	...	...	...
Office	15	Both	Yes	A

Now, you want to design a fully connected deep neural network using these 4 attributes as inputs that may suggest any of the 3 types. After a lot of trials and discussions with experts, you found a handsome network that has 3 hidden layers. The first layer has 3 neurons, the next one has 4 and the last one has 2 layers. **Draw the structure of the neural network.**

2. **[10 marks]** Now you want to design a road sign (turn right, turn left, no horn, etc.) detector robot. Hence you took a lot of photos of traffic signals so that you can develop a CNN model. Sample input and a kernel are given below. Find the output of the convolution layer after this kernel has been applied. Also, do the Max pooling of your convolution layer.

Input image			
0.5	0.4	0.2	0.2
0.3	0.3	0.7	0.8
0.1	0.0	0.0	0.4
0.7	0.6	0.9	0.9

Kernel 2		
0.6	0.1	0.2
0.2	0.4	0.2
0.3	0.2	0.6

Kernel 1		
0.5	0.3	0.2
0.1	0.6	0.3
0.4	0.1	0.5

Convolution using Kernel - 2.

$0.5 \times 0.6 + 0.4 \times 0.1 + 0.2 \times 0.2 + 0.3 \times 0.2 + 0.3 \times 0.4 + 0.7 \times 0.2 + 0.1 \times 0.3 + 0.0 \times 0.7 + 0.0 \times 0.6$

$= \boxed{0.73}$

$0.4 \times 0.6 + 0.2 \times 0.1 + 0.2 \times 0.2 + 0.3 \times 0.2 + 0.7 \times 0.4 + 0.8 \times 0.2 + 0.0 \times 0.3 + 0.0 \times 0.2 + 0.4 \times 0.6$

$= \boxed{1.04}$

$0.3 \times 0.6 + 0.3 \times 0.1 + 0.7 \times 0.2 + 0.1 \times 0.2 + 0.0 \times 0.4 + 0.0 \times 0.2 + 0.7 \times 0.3 + 0.6 \times 0.2 + 0.9 \times 0.6$

$= \boxed{1.24}$

$0.3 \times 0.6 + 0.7 \times 0.1 + 0.8 \times 0.2 + 0.0 \times 0.2 + 0.0 \times 0.4 + 0.4 \times 0.2 + 0.6 \times 0.3 + 0.9 \times 0.2 + 0.9 \times 0.6$

$= \boxed{1.39}$

0.73	1.04
1.24	1.39

2x2

2x2 Maxpooling, Stride = 1, Padding = 0 →

1.39

1 x 1

Convolution using Kernel - 1

$0.5 \times 0.5 + 0.4 \times 0.3 + 0.2 \times 0.2 + 0.3 \times 0.1 + 0.3 \times 0.6 + 0.7 \times 0.3 + 0.1 \times 0.4 + 0.0 \times 0.1 + 0.0 \times 0.5$

$= \boxed{0.87}$

$0.4 \times 0.5 + 0.2 \times 0.3 + 0.2 \times 0.2 + 0.3 \times 0.1 + 0.3 \times 0.6 + 0.8 \times 0.3 + 0.0 \times 0.4 + 0.0 \times 0.1 + 0.4 \times 0.5$

$= \boxed{1.19}$

$0.3 \times 0.5 + 0.3 \times 0.3 + 0.7 \times 0.2 + 0.1 \times 0.1 + 0.0 \times 0.6 + 0.0 \times 0.3 + 0.7 \times 0.4 + 0.6 \times 0.1 + 0.9 \times 0.5$

$= \boxed{1.18}$

$0.3 \times 0.5 + 0.7 \times 0.3 + 0.8 \times 0.2 + 0.0 \times 0.1 + 0.0 \times 0.6 + 0.4 \times 0.3 + 0.6 \times 0.4 + 0.9 \times 0.1 + 0.9 \times 0.5$

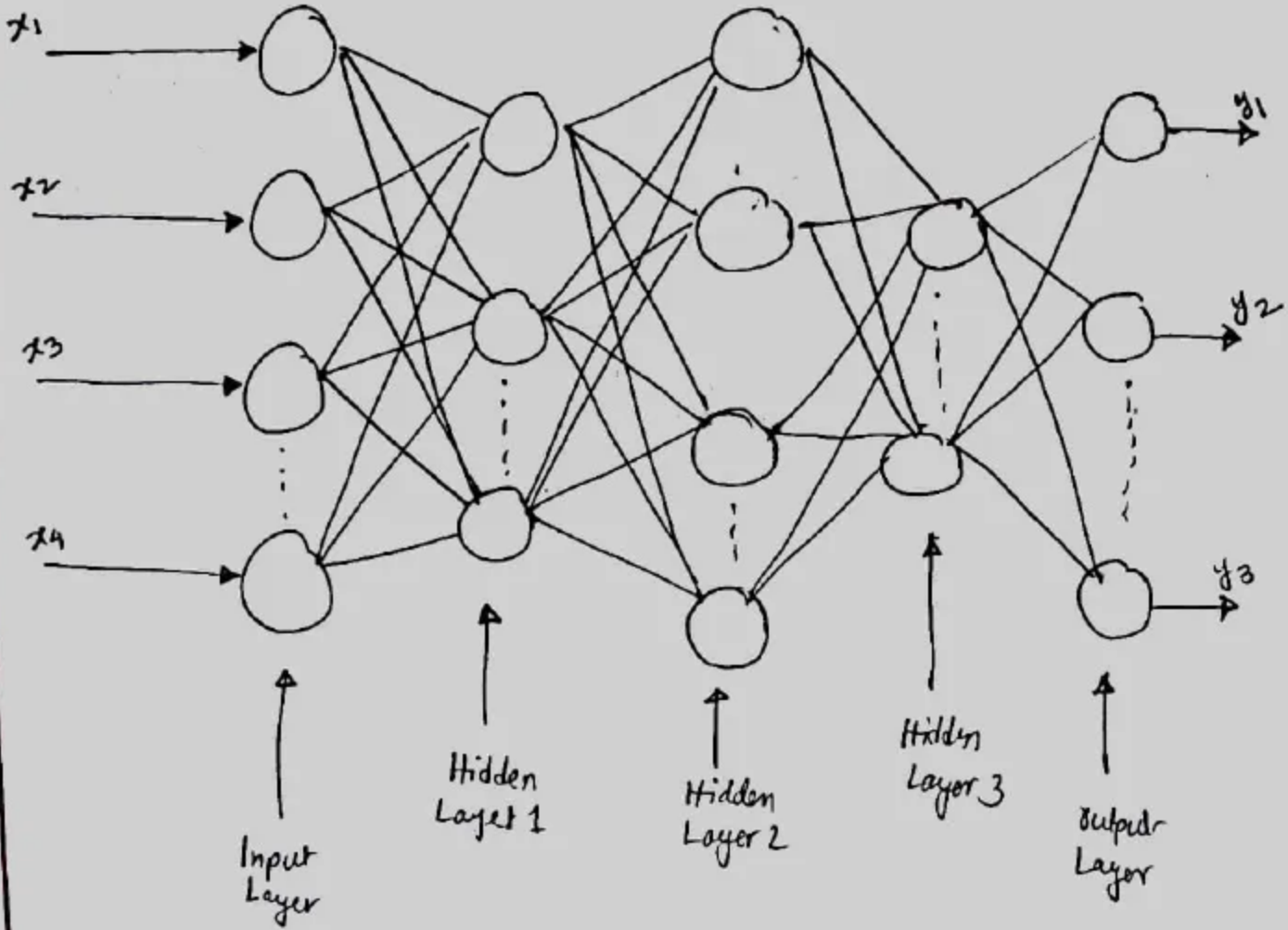
$= \boxed{1.42}$

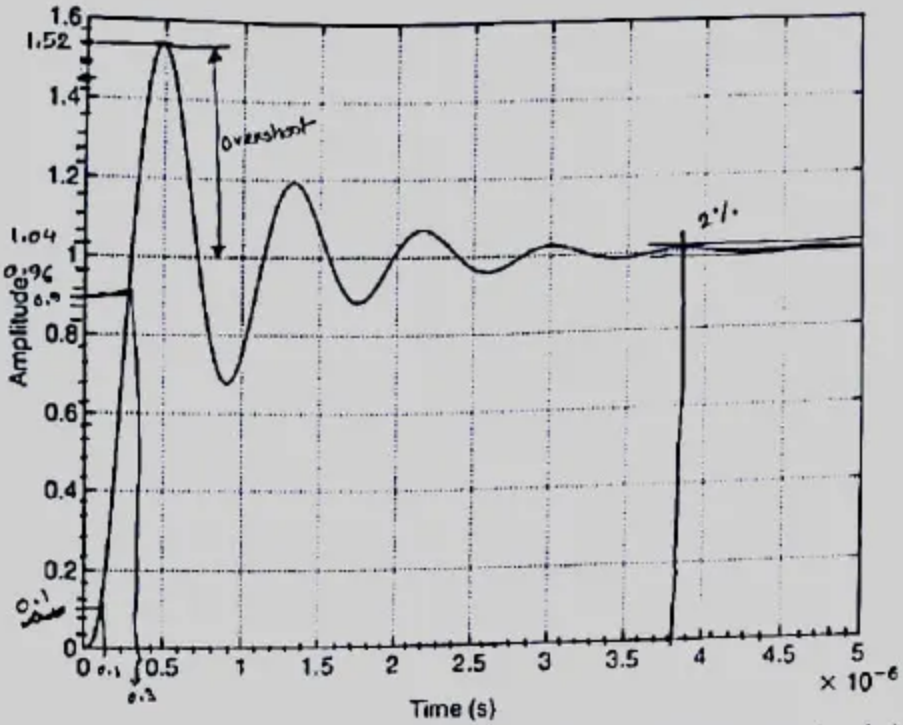
0.87	1.19
1.18	1.42

2x2 Maxpooling, Stride = 1, Padding = 0 →

1.42

1 x 1


x1
x2
x3
x4
y1
y2
y3
Input Layer
Hidden Layer 1
Hidden Layer 2
Hidden Layer 3
Output Layer



5. Define the Overshoot, Rise Time, and Settling time of a second-order response in relation to the given graph. [6 Marks]

Overshoot → percentage of final value exceed at first oscillation.

Rise time → time to span from 10% to 90% of the final value.

Settling time → time to reach within 2% or 5% of the final value.

$$\text{Overshoot} = \frac{1.52 - 1}{1} \times 100\% = \boxed{52\%}$$

$$10\% \times 1 = 0.1 \rightarrow t_{10\%} = 0.1 \times 10^{-6}\,s$$

$$90\% \times 1 = 0.9 \rightarrow t_{90\%} = 0.3 \times 10^{-6}\,s$$

$$\text{Rise time} = t_{90\%} - t_{10\%} = (0.3 - 0.1) \times 10^{-6}\,s = \boxed{0.2 \times 10^{-6}\,s}$$

Assume, tolerance band → 2%

$2\% \times 1 = 0.02$

Upper limit → $1 + 0.02 = 1.02$

Lower limit → $1 - 0.02 = 0.98$

Settling time → $\boxed{3.7 \times 10^{-6}\,s}$